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SUPPLEMENTAL WATER for the MILK RIVER

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MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION DNRC

WATER RESOURCES DIVISION

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SUPPLEMENTAL WATER

for the

MILK RIVER

The State of Montana	Thomas L. Judge Governor
The Montana Department of Natural Resources and Conservation	John C. Orth Director
The Water Resources Division	Orrin Ferris Administrator

Montana Department of Natural Resources and Conservation
Helena
and
U.S. Department of Interior
Bureau of Reclamation
Region 6

February 1977
Helena, Montana

This study was conducted in compliance with House Bill 642 (1975), using funds appropriated by that bill.

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SUMMARY

A study of the possibilities of the diversion of water into the Milk River was directed by the 1975 state legislature (HB 642). This report, a cooperative study by the Montana Department of Natural Resources and Conservation (MDNRC) and the U.S. Bureau of Reclamation (USBR), is a result of that request. The objectives of the study were to determine, on a reconnaissance level, what water shortages, if any, exist in the Milk River mainstem and to determine the possibilities of providing a supplemental water supply to the basin.

Present and future condition (historic inflow and inflow less Canada's share) studies indicate a need for supplemental flow. In the present condition study, the Milk River lands for the period 1964 to 1973 have had average annual shortages of 38,000 acre-feet. The future condition study for the same period showed that the lands have had an average annual shortage of 49,200 acre-feet. The figures above are for the average annual irrigation season only.

Four diversion alternatives were chosen for the study and they are listed below and summarized in table 1:

Route 1: MARIAS-MILK DIVERSION
Lake Elwell (Tiber Reservoir) to Fresno Reservoir via Lonesome Lake Area and Big Sandy area; water source is the Marias River (map 1, page 7 and map 2, page 27).

Route 2: VIRGELLE-HAVRE DIVERSION
Virgelle area to mouth of Big Sandy Creek near Havre; water source is a pump lift from the Missouri River (map 1, page 7 and map 2, page 27).

Route 3: TELEGRAPH CREEK-BEAVER CREEK DIVERSION
Telegraph Creek, on the UL Game Refuge, via Beaver Creek to Nelson Reservoir; water is taken by pump from Fort Peck Reservoir (map 1, page 7 and map 3, page 35).

Route 4: DUCK CREEK-VANDALIA DIVERSION
Duck Creek Arm on the C.M. Russell National Wildlife Range to the Vandalia area, with service to Glasgow bench; water is taken from Fort Peck Reservoir by a gravity flow canal some 90 feet deep (map 1, page 7 and map 3, page 35).

The studies showed that three of the four diversion schemes would adequately provide a full-service water supply to the Milk River lands. Full service was provided by the Marias-Milk, Virgelle, and Telegraph Creek alternatives. The Vandalia plan increased the amount of water for diversion upstream of the Vandalia area but was short of that needed for full service.

TABLE 1

SUMMARY OF ALTERNATIVES
INTERBASIN DIVERSION ROUTES

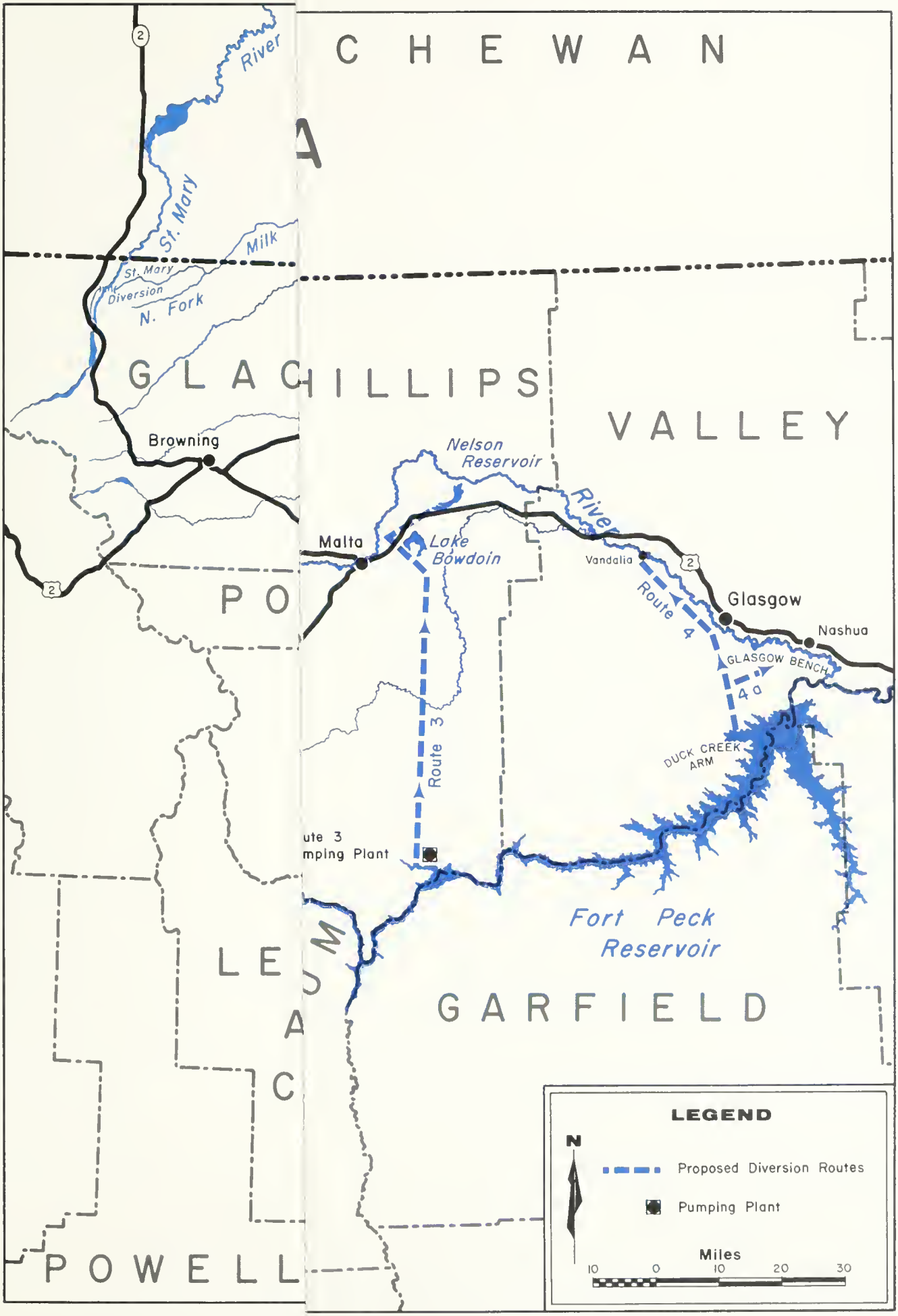
	ALTERNATIVE ROUTES			
	#1 MARIAS-MILK	#2 VIRGELLE-HAVRE	#3 TELEGRAPH CR.-BEAVER CR.	#4 DUCK CREEK-VANDALIA
LEGAL RESTRICTIONS	usual[a]	usual & Wild & Scenic River	usual & National Wildlife Range	usual & National Wildlife Range
EFFECTS ON WILDLIFE (see appendix A)	benefits	none	benefits	adverse
(For more details on the remainder of this Summary, see appendix B)				
NEW ACRES (FULL SERVICE)	72,700	24,000	2,000	27,000
SUPPLEMENTAL ACRES	108,140[b]	108,140[b]	108,140[b]	53,200
NATIONAL ECONOMIC DEVELOPMENT	unfavorable	favorable	favorable	favorable
Benefit: Cost ratio Full service & supplemental	0.84:1.00	1.34:1.00	2.17:1.00	1.01:1.00
REGIONAL DEVELOPMENT	favorable	favorable	favorable	favorable
Benefit:Cost ratio Full service & supplemental	1.83:1.00	2.91:1.00	4.69:1.00	2.25:1.00
COSTS, FULL SERVICE & SUPPLEMENTAL	$181,750,000	$ 72,210,000	$ 39,994,000	$ 54,612,000

BENEFITS (ANNUAL $ PER ACRE)				
Full Service	70	70	70	70
Supplemental service	45	45	45	45
REPAYMENT PLAN #1[c] (annual $ per acre)				
Full Service Plan				
Costs, full service & supplemental	$170.47	$169.63	$152.15	$118.81[d]
REPAYMENT PLAN #2[e] (annual $ per acre)				
Full Service Plan				
Costs, full service & supplemental	43.80	47.63	41.65	33.11
REPAYMENT PLAN #3[f] (annual $ per acre)				
Full Service Plan				
Costs, full service & supplemental	g	18.01	14.65	12.34

a Usual - rights of way & property acquisition
b This acreage does not include 16,000 acres irrigated by private pumping
c Repayment Plan #1 - funds borrowed from lending institution, or sale of bonds for 50 years at 8% interest
d This value is for the first 25 years; for the second 25 years, the value is $126.75
e Repayment Plan #2 - funds borrowed from U.S. Government by Irrigation District for 50 years at no interest
f Repayment Plan #3 - Pick-Sloan Missouri River Basin Power Plan, costs offset by sale of electrical energy
g These values were not calculated because NED benefit-cost ratio was unfavorable

In addition to the water supply capacity of each of the four routes, there are economic, legal, and environmental impacts that are associated with each of the routes. Should one of the diversion routes be chosen, a feasibility level study would be required, and an environmental impact statement prepared, to determine the feasibility of constructing that route.

In the event none of these routes are chosen for import, other measures of alleviating the shortage should be examined, such as additional storage or possible increased diversion of the St. Mary River. If no additional water can be diverted into the basin, it may be necessary to curtail or cease the granting of water use permits on the mainstem Milk River.


CHEWAN
A
River
St. Mary
Milk
St. Mary
Diversion
N. Fork
GLAC
HILLIPS
VALLEY
Browning
Nelson
Reservoir
Riv
Malta
Lake
Bowdoin
Vandalia
2
Route 4
Glasgow
Nashua
GLASGOW BENCH
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DUCK CREEK
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Proposed Diversion Routes
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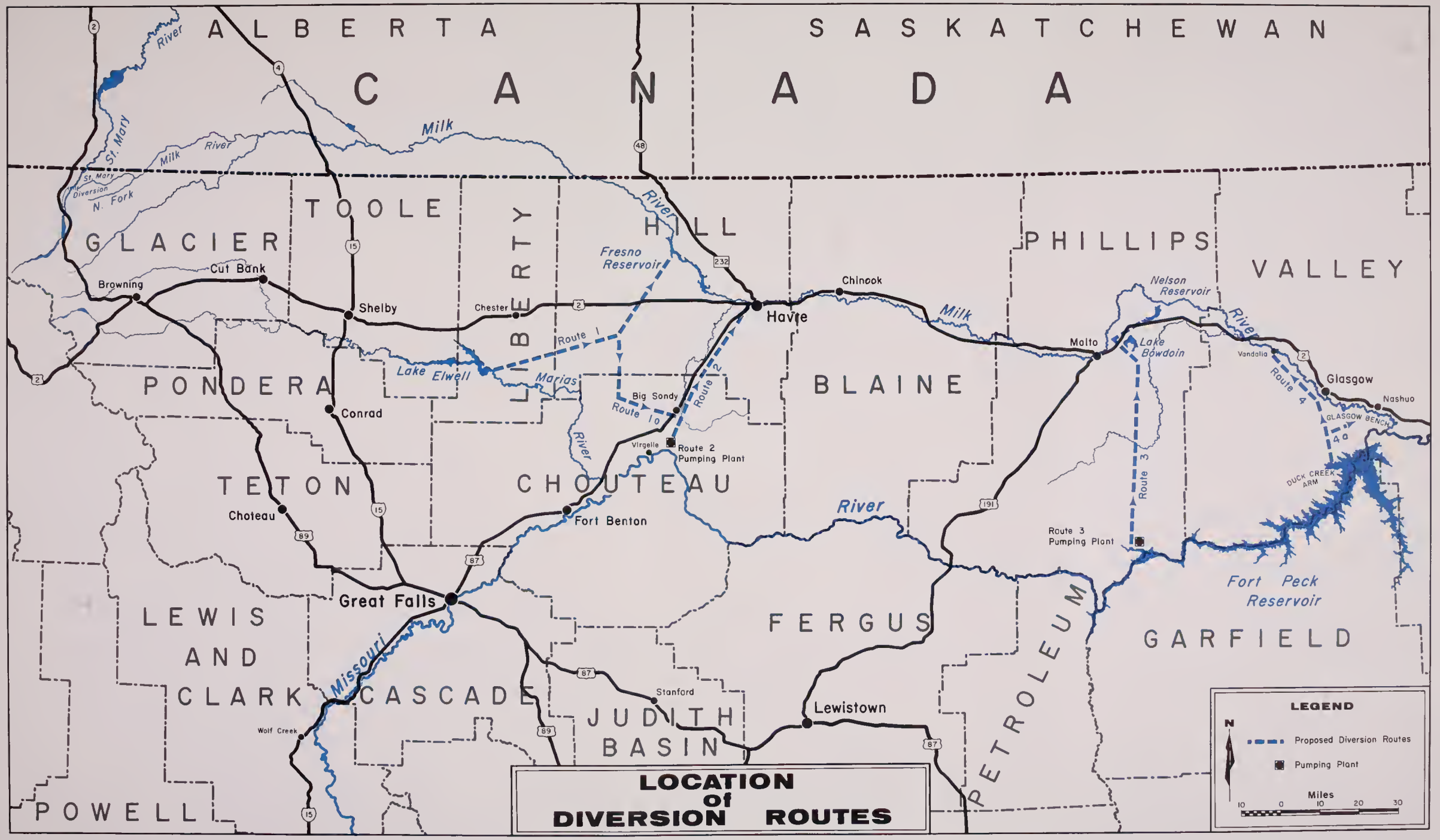

ALBERTA
SASKATCHEWAN
CANADA
St. Mary River
Milk River
St. Mary Diversion
N. Fork
Milk River
TOOLE
GLACIER
LIBERTY
HILL
PHILLIPS
VALLEY
Fresno Reservoir
River
Browning
Cut Bank
Shelby
Chester
Havre
Chinook
Nelson Reservoir
Milk
River
Malta
Lake Bowdoin
Vandalia
Glasgow
Nashua
Route 1
Route 2
Route 4
GLASGOW BENCH
Lake Elwell
Marias
PONDERA
BLAINE
Big Sandy
Route 10
Conrad
River
Virgelle
Route 2 Pumping Plant
TETON
CHOUTEAU
Route 3
DUCK CREEK ARM
Choteau
Fort Benton
River
Route 3 Pumping Plant
Fort Peck Reservoir
Great Falls
LEWIS AND CLARK
CASCADE
FERGUS
PETROLEUM
GARFIELD
Missouri
Stanford
Lewistown
JUDITH BASIN
Wolf Creek
POWELL
LOCATION of DIVERSION ROUTES
LEGEND
N
Proposed Diversion Routes
Pumping Plant
Miles
10 0 10 20 30

INTRODUCTION

INTRODUCTION

Authority

This study was directed under the provisions of House Bill 642, Chapter 533, Montana Session Laws, enacted by the Forty-fourth Legislature, effective July 1, 1975.

Study Area

The study is limited to the area traversed by the Milk River from Eastern Crossing (49°N, 110°30'36"W) in Hill County, to the juncture of the Milk and Missouri rivers in Valley County (48°3'N, 106°18'W) and those areas crossed by potential diversion routes (map 1, page 7). These limits were chosen because the specified areas will be most directly affected by any of the potential diversions, and they are the most extensively irrigated areas. A study of tributary flow was not conducted because tributaries will be indirectly affected by any diversion.

The study area lies in the northern tier of Montana counties, often called the "High Line" counties, including Hill, Blaine, Phillips, Valley, and small parts of Liberty and Chouteau counties. The Milk River arises in three forks on the Blackfoot Reservation, Glacier County, at roughly 113°20'W, 48°45'N, east of the Continental Divide. Milk River streamflow is augmented by a diversion from the St. Mary River during irrigation season. The Milk River flows through the Province of Alberta and then reenters the United States in Hill County. It then flows approximately 245 miles to its confluence with the Missouri. Table 2 shows the principal tributaries.

TABLE 2

PRINCIPAL TRIBUTARIES OF THE MILK RIVER

Creeks Arising in U.S.		Creeks Arising in Canada
Big Sandy	Peoples	Frenchman
Beaver (Hill County)	Alkali	Whitewater
Bullhook	Beaver (Phillips County)	Rock
Box Elder	Larb	Battle
Clear	Willow	Lodge
Snake	Porcupine	
White Bear		

Legal Restrictions

Boundary Waters Treaty

Because part of the Milk River flows through Canada, the use of the water has been affected by international agreement (U.S. Congress 1968). A Boundary Waters Treaty was signed in 1909 by representatives of the United States and Great Britain, dealing with waters that cross the boundary between the United States and Canada. Article VI of the Treaty stipulates that during the irrigation season, April 1 through October 31, the United States is entitled to 500 cubic feet per second (cfs) of the Milk River flow, or 75 percent of its natural flow. Article VIII of the Treaty sets priority on use of the water as follows:

1) Domestic and sanitary purposes
2) Navigation
3) Power and irrigation

The International Joint Commission (IJC) in 1921, amended the aforementioned Article VI to give the United States 75 percent of the flow up to 666 cfs. Any volume greater than this is divided equally between the United States and Canada.

The Winters Case

The river's course crosses one Indian reservation in the area of study; Fort Belknap Reservation, as determined by the Winters case, 1908, has rights to 125 cfs of the flow. This volume may be only a part of the rights, depending upon future adjudication. The "Winters Doctrine" arising from the Winters case also applies to the Blackfeet Reservation, on which the river arises, as well as the Rocky Boy Reservation near which two diversion routes pass.

Irrigation Restrictions

Reclamation law limits the amount of acreage in a single ownership to 160 acres which is eligible to receive water from a federal reclamation project. The 160-acre figure is based upon the ability of the land to produce, using the soils class and a 180-day growing season as the main criteria. In the past, many of the families receiving water from a federal project have increased their eligible acres by deeding 160-acre parcels to each member of the family, or by simply not complying with the law. According to the Bureau of Reclamation personnel, the Bureau is required to enforce acreage limitation on projects under its control.

Since 1958, the Congress has included a Class I equivalency provision on reclamation project authorization. The Class I equivalency concept provides that eligible acreages may be increased in areas where agricultural productivity is limited because of poor soils or short growing season.

An example of equivalency is the East Bench Project of the Bureau of Reclamation near Dillon, Montana. Equivalency ratios are set by land class, as follows: Class 1-1:1.00; 2 - 1:1.23; 3- 1:1.69; and 4P - 1:3.38. For example, in calculating Class 2 land, one multiples 160 acres by 16/13 to get 197 acres.

Under this equivalency, a user could irrigate 160 acres of class 1 land, 197 acres of class 2, 271 acres of class 3, and 541 acres of class 4P (pasture) or combinations thereof.

During the 94th Congress, hearings were held on legislation which would have provided for the Class I equivalency concept to be automatically included for projects with less than a 180-day frost free growing season. Governor Judge endorsed the equivalency concept in a letter sent to Congressman Harold Johnson on July 20, 1976. He stated that in his opinion that the proposed legislation did not go far enough in resolving the limitation problem but that he did feel that the legislation would have been a step in the right direction. The legislation was defeated on the House floor and as a result the Senate never acted on the bill. It is expected that similar legislation will be introduced in the current session.

Climate

The climate of the area is typical of the high plains province: semiarid with occasional droughts, long warm summer days with cool nights, and cold winters. Precipitation varies throughout the year but most falls from April through June. Table 3 shows long-term climatological records.

TABLE 3

SELECTED CLIMATE DATA

Average annual precipitation	12 + inches
Average April-June precipitation	9 + inches
Average annual temperature	43 + ^{o}F
Maximum recorded temperature	109 ^{o}F
Minimum recorded temperature	-57 ^{o}F
Average annual consecutive frost-free period	126 days
Growing season (consecutive days at 25^{o} or higher)	175 days

SOURCE: State Water Conservation Board 1967-69.

Geology, Soils, and Ground Water

After reentry into the United States, the stream flows across Cretaceous bedrock which has been covered by a veneer of glacial debris, ranging in thickness from a thin, scattered stratum to 200 feet. These glacial remains and the period of glaciation have governed the extant soil and topography of the area.

From Havre downstream, the Milk River flows in a preglacial Missouri River valley, the Missouri having been moved to its present course by glaciation.

The soil is variable, some places being excellent for crops and others being poorly drained and unfit for crops. Ground water in glacial debris of the area is often unreliable in both quantity and quality; small recharge areas limit quantity. Soluble salts in the soil result in unusable water in many places. Poor drainage, coupled with these salts, causes an increasing saline seep problem. Deeper aquifers lie under the basin, but detailed studies to determine depths, quality, areal extent and available quantity are needed.

There are a few mineral resources in the area (table 4), and these have not been exploited in the recent past.

TABLE 4

MINERAL RESOURCES IN THE MILK RIVER AREA

Hill County	Vermiculite	near Box Elder in Bearpaws
	rare earth	"
	niobium	"
	clay	many sites
	oil & gas	central area
	coal (sub-bituminous)	many sites
	bentonite	northeast portion
	gold	very little, in mountains
	sand & gravel	in stream & glacial deposits
Blaine County	coal (sub-bituminous)	scattered
	bentonite	"
	sand & gravel	in stream & glacial deposits
	oil & gas	west central; southwest area
Phillips County	gold	very little, Little Rockies
	oil & gas	southwest corner; central
	fluorspar	Little Rockies
	coal (sub-bituminous)	southwest corner
	bentonite	southern quarter
	sand & gravel	instream & glacial deposits
Valley County	lignite (thin layers)	northeast corner
	bentonite	scattered
	salt	extreme east central
	sand & gravel	instream & glacial deposits
	oil & gas	west central
Liberty County	iron	Sweet Grass Hills
	fluorspar	"
	oil & gas	central area
	coal (sub-bituminous)	scattered
	gold	little, Sweet Grass Hills

SOURCE: Montana Bureau of Mines and Geology and U.S. Geological Survey 1963.

It is probable that if any or several of these localities for resources were developed, an additional demand would be made for water.

Potentially Irrigable Lands

Maps 2 and 3, pages 27 and 35 , show areas that are presently irrigated and those that are potentially irrigable, along the river itself and along proposed diversion routes. The term "potentially irrigable" applies to land which has soil capable of bearing crops and which has a slope that can be tilled using existing machinery. Much of this land cannot be irrigated by flood techniques but would require sprinkling equipment.

Overall, there are perhaps 8 percent of the 2,000,000 tilled acres irrigated. New technological advances in irrigation equipment and practices will make it possible for a greater portion of tilled land to be put under irrigation, assuming water is available.

Crops

For the period 1944 to 1973, the most common crops were the grains (wheat, rye, barley, oats). Only about 1.5 percent of these crops have been irrigated in the past and often more than 2,000,000 acres were planted in a year. Other crops included tame hay (including alfalfa), with about 125,000 acres annually, of which 50 percent was irrigated, and wild hay, with about 70,000 acres annually, of which approximately 33 percent was irrigated. Sugar beets, 100 percent irrigated, had a high acreage of 10,250 acres in 1945, and a low of 577 acres in 1973.

Water-Related Problems

Mosquitoes

In the past, many people have complained about the prevalence of mosquitoes and their nuisance to both humans and stock. Many controls are possible but recent environmental studies indicate that chemical controls, i.e., oil or poisons,are inadvisable. At least two biological controls have been tried, the mosquito fish (Gambusia affinis) and the purple martin (Progne subis) (Kale 1968). The mosquito fish does not winter well in Montana, and water areas must be restocked each spring. The martin has been shown to be an ineffective control because they feed at times when mosquitoes are at least active. Other biological controls may be possible, among them are: a parasitic microfauna that kills mosquito larvae, and a non-biting mosquito whose larvae eats all other mosquito larvae (Chapman 1974, National Academy of Sciences 1973).

Poor irrigation practices may well aggravate the problem but are not the sole contributor. The nature of the terrain permits many small catchment areas which are natural breeding grounds. Increased irrigation will generally not affect these areas.

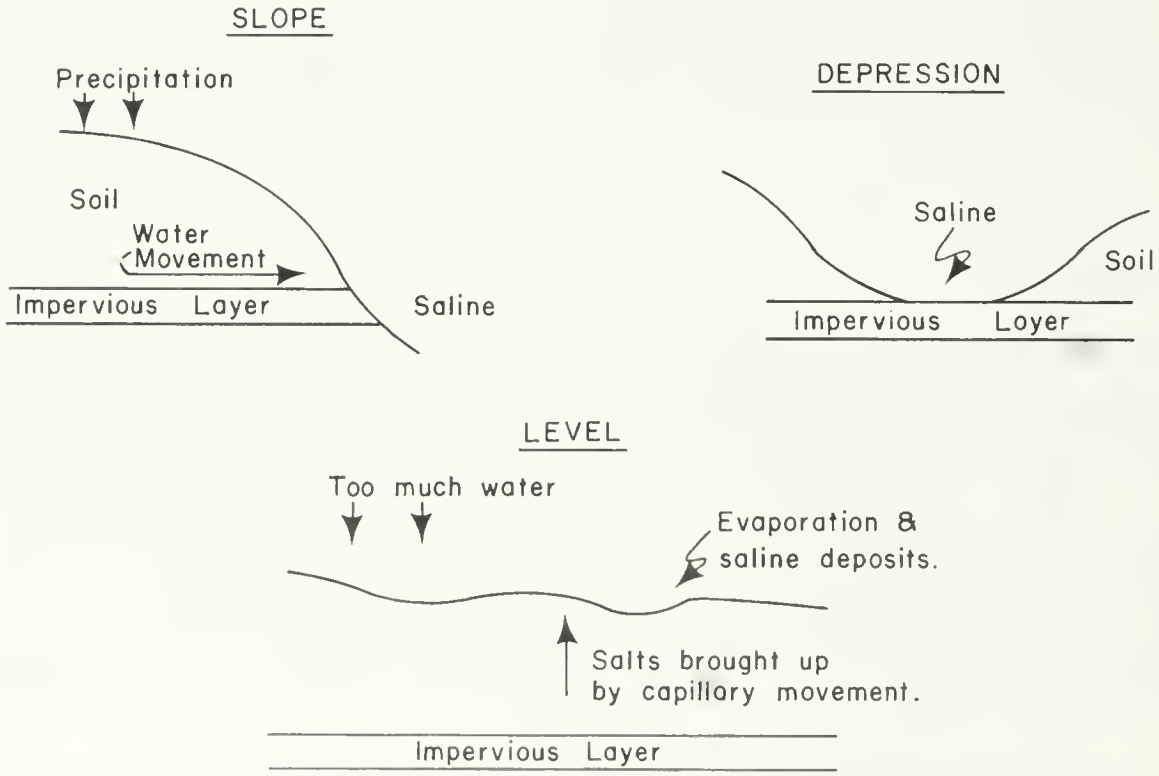
In summation, it is felt that increased irrigation will not appreciably affect the mosquito problem along the "High Line." Research into different methods of biological controls is necessary.

Saline Seep

Much of the formerly glaciated area of northern Montana is subject to saline seep. Water soluble salts were left in the glacial debris, and modification into soil in the semiarid region did not leach the salts, e.g., solution and transport out of the area by streams. Under conditions of too much water, these salts are brought to the surface by capillary action, concentrated, and precipitated by evaporation, and the uppermost stratum of soil is rendered temporarily sterile. The cross sections shown in figure 1 generally explain this phenomenon.

Some reports have noted that strip farming techniques with crop fallow rotations have aggravated the problem. Certainly, poor irrigation techniques do aggravate it. At this time there is no full solution to the situation.

Several landowners along proposed diversion routes have expressed concern about lateral seepage from canals and resulting saline concentrations.



CROSS-SECTION SHOWING SALINE SEEP PROBLEM

Figure 1

Population

Population in the "High Line" counties and towns is shown in Table 5.

TABLE 5

POPULATION OF COUNTIES AND TOWNS

County	County Total	Urban (2500 or more)	Rural	% Rural	Largest Town(s)	Town Total
Blaine	6,727	-	6,727	100	Chinook Harlem	1,813 1,094
Choteau	6,473	-	6,473	100	Big Sandy Fort Benton	827 1,863
Hill	17,358	10,558	6,800	39.2	Havre	10,558
Liberty	2,359	-	2,359	100	Chester	736
Phillips	5,386	-	5,386	100	Malta	2,195
Valley	11,471	4,700	6,771	59	Glasgow	4,700

SOURCE: Montana Department of Planning and Economic Development 1970, p. 4:10, 4:12, 4:17, 4:18.

Population growth in the rural areas is expected to be negligible, in the foreseeable future. In towns other than Chinook, Glasgow, and Havre, populations should remain stable. Chinook has a growth potential based on the possible construction of a coal gasification plant and the use of nearby coal. Glasgow has a growth potential if uses can be found for the air base. Already the area's largest city, Havre seems the most likely area to increase in population since further development of local coal and natural gas supplies will attract new inhabitants. The city is expected to become an even larger service center for northern Montana and southern Alberta and Saskatchewan.

Existing Water Use

A total of 108,140 acres of land are presently being irrigated from water made available from seven existing irrigation projects. An additional 16,000 acres of land is being irrigated by individuals who are pumping out of the Milk River and existing ditches. These irrigated acreages were obtained from county water resource surveys published by the Department of Natural Resources and Conservation. Table 6 shows the breakdown of lands by irrigation district and diversions as well as the distribution and acreage of privately served lands.

TABLE 6

EXISTING PROJECT IRRIGATED ACREAGES

Diversion Structure	Irrigation District	Acreage
Fort Belknap	Fort Belknap	6,482
	Alfalfa Valley	3,664
	Zurich	7,664
Harlem Pumps	Harlem	11,148
Paradise	Paradise Valley	8,315
Fort Belknap Agency		10,425
Dodson	Dodson North	9,525
	Dodson South	15,830
	Dodson Pump	1,147
Nelson Reservoir	Nelson South	15,930
Vandalia	Vandalia South	18,010
TOTAL		108,140

Private Pump Between Diversion Dams	
1. Above Fort Belknap	1,660
2. Fort Belknap to Paradise	1,180
3. Paradise to Harlem Pump	528
4. Harlem Pump to Fort Belknap Agency	0
5. Fort Belknap to Agency to Dodson	1,182
6. Dodson to Vandalia	7,948
7. Below Vandalia	3,500
TOTAL	16,000

Irrigation requirements for the irrigated lands in the study area are shown in table 7, while the return flows from irrigated land are shown in table 8.

TABLE 7

IRRIGATION REQUIREMENTS

Consumptive Use[a]	2.03 af/acre
Annual Effective Precipitation[b]	-.67 af/acre
	1.36 af/acre
40% Farm Losses and Wastes	.91 af/acre
Farm Delivery Requirements	2.27 af/acre
35% Conveyance Losses and Wastes	1.23 af/acre
Annual Diversion Requirements	3.50 af/acre
Present Irrigation Under Private Pump Annual Diversion Requirements	2.00 af/acre

Monthly Distribution of Annual Diversion Requirements[c]

Month	Percent Distributions
April	3
May	14
June	20
July	25
August	20
September	13
October	5
TOTAL	100

SOURCE: U.S. Department of Interior 1976.

a Lowry-Johnson method - average consumptive use for weather station at Malta.

b Done according to Bureau of Reclamation methods, using 90 percent of the five driest years, 1956-1960.

c Taken from Milk River Projects Reports, Bureau of Reclamation.

TABLE 8

RETURN FLOWS FROM MILK RIVER VALLEY LANDS

Existing Gravity System	af/acre
Diversion Requirements	3.50
Consumptive Use of Irrigation Water	-1.36
Gross Possible Return Flow	2.14
Irrecoverable Loss (30%)	- .64
Net Return Flow	1.50
Private Pumpers (contract) From Lands Served by Pumping From Milk River	
Diversion Requirement	2.00
Consumptive Use of Irrigation Water	-1.36
Gross Possible Return Flow	0.64
Irrecoverable Loss (20%)	-0.13
Net Return Flow	0.51

SOURCE: U.S. Department of Interior 1976.

Other water use in the study areas include supplies for municipal and waterfowl habitat. These diversions are shown by location in table 9.

TABLE 9

MUNICIPAL USE OF THE MILK RIVER

Town	Service Contract (acre-feet/year)
Chinook[a]	400
Harlem	500
Havre[a]	600

SOURCE: U.S. Department of Interior 1976.

[a]In addition, Chinook and Havre have a contract for a minimum of 25 cfs or 1,500 acre-feet per month for sewage abatement. This water returns to the Milk River after use.

Water Quality

Water quality of the Milk River was found to be good upstream of Havre, Montana. It becomes progressively poorer downstream of Havre because of agricultural returns and municipal discharges. State water quality classifications for the Missouri River and the Milk River are both B-D_3. The Marias River classification is B-D_2. The "B" in both classifications means "water supply for drinking, culinary, and food processing purposes," and the "D_2" and "D_3" refer to specific water quality criteria. Conclusions from the Water Quality Inventory and Management Plan (Montana Department of Health and Environmental Sciences 1974) state that water quality in the Milk River Basin will meet State water quality standards by July 1, 1977, when facilities are completed to improve municipal and livestock waste treatment. A detailed study of the effects of augmented flow on water quality in the Milk River would be required prior to any development.

PART I
ALTERNATIVE DIVERSIONS

Economic Analysis Methodology

Appendix B, Supplemental Water Supply: Economic and Repayment Analysis, Milk River Basin, prepared by the U.S. Bureau of Reclamation, contains detailed explanations of the methodology and assumptions that were utilized. Certain of the methodologies warrant additional clarification and are explained below.

1. Benefits

The irrigation benefits are based on deriving a net income figure for an average farm unit in the study area using the farm budget analysis approach detailed in appendix C. Full service and supplemental service benefits are projected using anticipated yields and farm sales based on increased yields over present conditions. Dependent upon the yields ultimately attained, the benefits could change substantially from those used in the report, particularly on those lands currently being irrigated which may not achieve the yields forecasted, even with supplemental water, due to soil capability constraints.

2. Costs

At the time the appendix reports were prepared, the Bureau used an interest rate of 6 1/8 percent. The current rate required to be used, as specified by the Water Resources Council, is 6 3/8 percent. Accordingly the costs are somewhat understated.

3. Plan Evaluation

Costs and benefits were analyzed using the three account system as provided in the Bureau guidelines for multi-objective planning of water resources planning (MOP). A description of each of the accounts is included in the appendix. In summary, NED (National Economic Development) criteria require that for a project to be considered feasible the direct benefits to the irrigators must exceed the total costs. RD (Regional Development) criteria provide that total benefits to all users or recipients of income must exceed total costs. Based on these criteria, benefit:cost ratios were derived which indicate the relative economic efficiencies or feasibility of the alternative routes described in this report. The benefit:cost ratios for the various alternative routes analyzed are contained in the Summary of Alternatives (table 1), pages 4-5 of the report.

4. Supplemental Acres

For Alternative Routes 1, 2, and 3, the Bureau report (appendix B) has used an acreage figure of 108,140 for assignment of benefits from supplemental water supplies being made available. This acreage is based on an inventory of lands which are currently being irrigated from water made available from existing irrigation projects. Shortages of water for these acres vary, with

certain of the lands being only 3 percent short, while other acreages are as much as 25 percent deficient in terms of full supply. Averaging the shortage across all of the 108,140 acres indicates an average shortage of 12+ percent. Benefit values for the supplemental benefits from an increased supply to a full service level were based on $45 value per acre. Dependent upon the actual water shortage on a given farm unit, the benefit values will vary.

Conclusions

Based on the economic analysis and evaluations made of the alternative diversion routes, it is concluded that Alternative Routes 1 and 4 are infeasible from an economic feasibility standpoint. Route 4, while indicating a NED benefit:cost ratio of 1:01:1.00, would not be feasible if lower yields are considered as opposed to the yield levels projected by the Bureau on the supplemental 53,200 acres. Accordingly, no further consideration shall be given to Routes 1 and 4 as feasible alternative diversion plans for the Milk River Basin.

At the level of analysis performed by the Bureau for Route 2 and 3, it appears that these routes may be feasible from an economic standpoint. This conclusion, however, should be further substantiated based on a more detailed feasibility level analysis. Based on the further study, it is possible that Route 2 may prove to be infeasible. Route 3, based on the analysis to date, appears to offer the greatest potential for economic feasibility.

Route 1: Marias - Milk

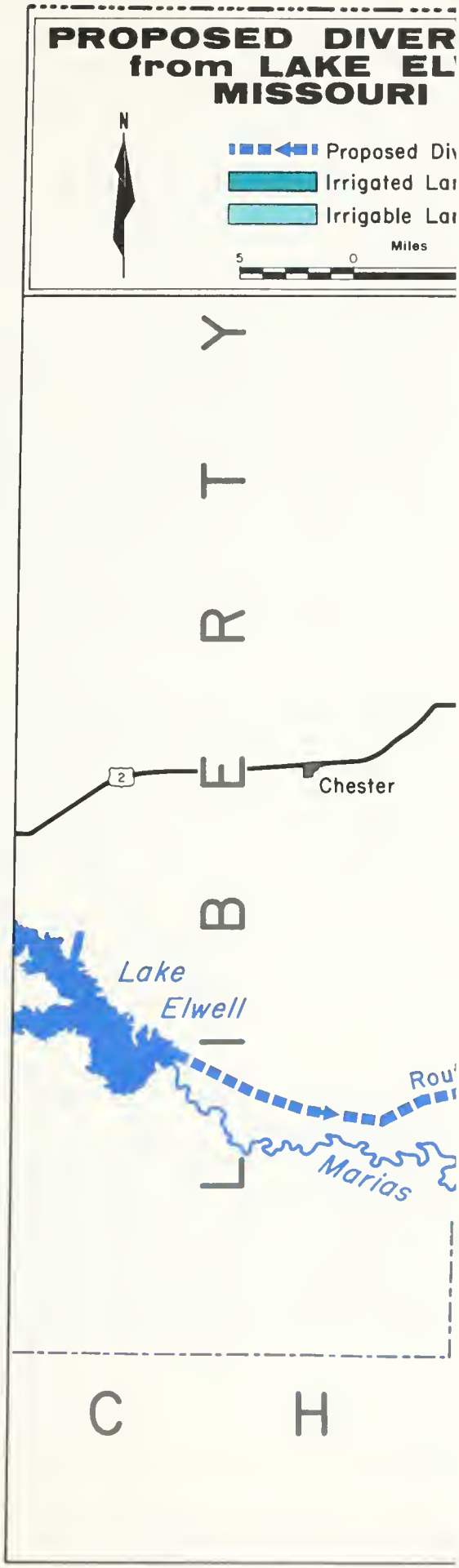
This route from Lake Elwell (Tiber Reservoir) to Fresno Reservoir has been examined in the past. This report is an updating of the economical aspects of the report on the Marias-Milk Unit (U.S. Department of Interior 1970).

Map 2, opposite page, shows the route, and appendix B contains a summary of the physical and economic aspects of the routes.

Full irrigation water is provided for new acreage as follows (new lands shown on map 2): Milk River, 19,900 acres; Central Marias Area, 37,800 acres; Big Sandy Area, 15,000 acres; for a total of 72,700 acres.

Supplemental water is provided for 108,140 presently irrigated acres downstream from Fresno Reservoir (irrigated lands shown on maps 2 and 3, pages 27 and 35).

This is the longest, most expensive of the alternative routes. If only the National Economic Development (NED) criteria are considered (i.e., direct user benefits must exceed total costs), the benefit:cost ratio obtained is 0.84:1.00 for the full service plan, and the plan is financially infeasible. If Regional Development (RD) criteria are considered (i.e., total benefits must exceed total costs) the benefit:cost ratio is 1.83:1.00, which is the lowest of the four alternative routes. This route does not cross wildlife refuges or wilderness areas and does not affect designated wild and scenic streams. It may be beneficial to wildlife by supplying additional water to the Lonesome Lake area and to the Chain-of-Lakes area. The Montana Department of Fish and Game


PROPOSED DIVER
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recommends this route (see appendix A). Of the four routes studied, it appears that this route has the most favorable impact on fish and wildlife game resources.

Proposed Engineering Plan

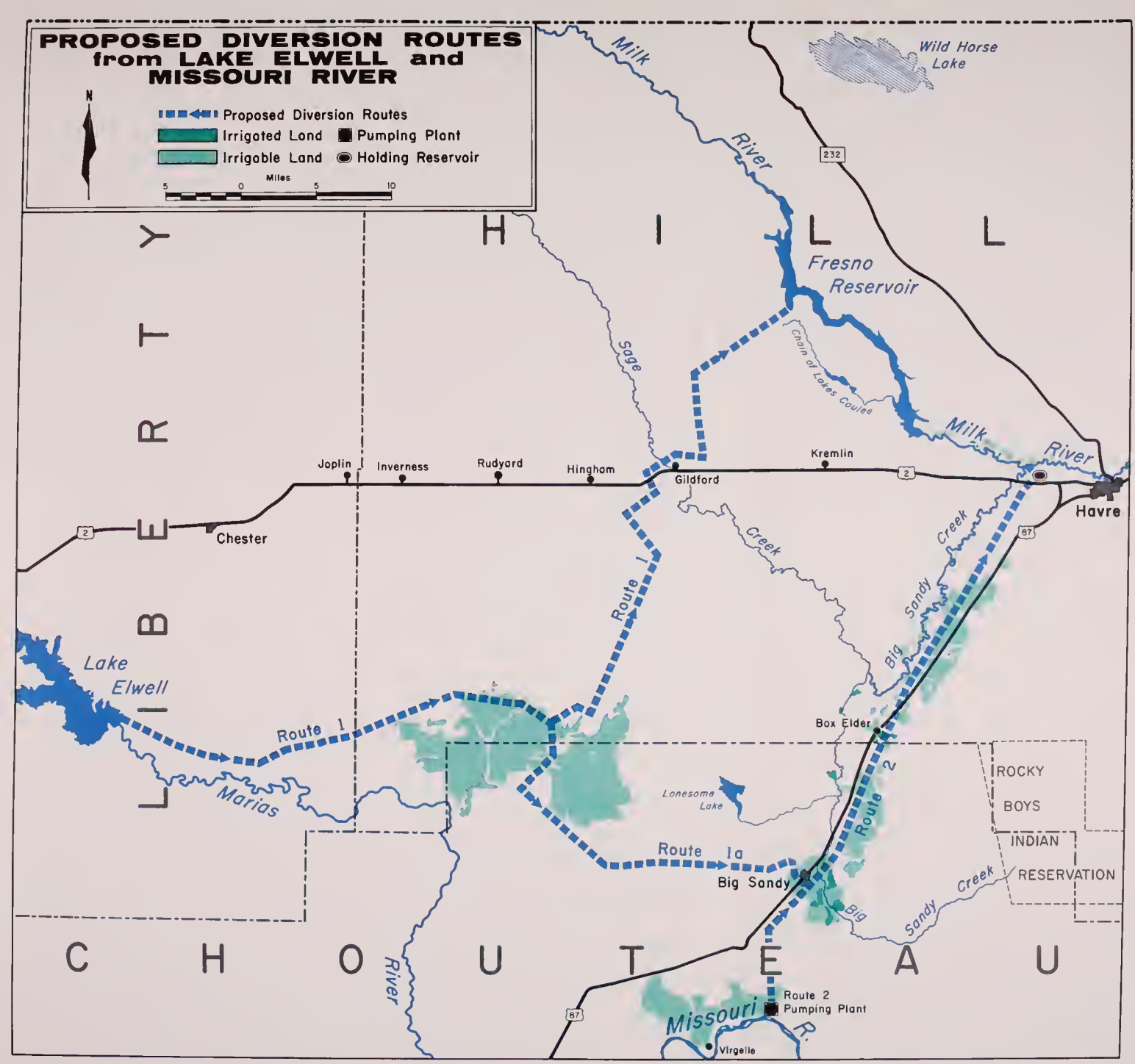
In order to release 1,500 cfs from Lake Elwell at the existing outlet tunnel, a 4,737-foot concrete-lined horseshoe tunnel, diameter 15 feet, will be located in the abutment of the dam. The outlet portal of this tunnel leads into the Marias-Milk Canal, (Route 1 direct to Fresno) extending 80.2 miles. Major structures consist of seven siphons (lengths ranging from 228 to 7,760 feet); a bifurcation structure for releasing water into the Big Sandy Canal; a fish filter or screen; 13 drops and a terminal drop into Fresno; numerous bridges for crossing; and 40 lateral and farm turnouts. Structures will include drainage inlets and cross drainage culverts. One lateral is constructed to divert water into Chain-of-Lakes Coulee for fish and game use. The upper end of all major structures will be equipped with appropriate protective and escape devices, such as safety nets and slope ladders to assist humans, livestock, and wild animals in escaping from the canal. Laterals required to serve irrigable lands from this canal range in capacity from 93 to 5 cfs. For estimating cost, concrete lining was assumed for all laterals with capacity of 50 cfs or less. Output into Fresno Reservoir is 400 cfs.

Big Sandy Canal, 64.2 miles long, with an initial capacity of 513 cfs and a terminal capacity of 15 cfs would require structures as follows: three siphons, 314-feet, 540-feet, and 17,410-feet long; three wasteways; one concrete chute, 1,330 feet long with three 8 x 7-feet radial gates; and numerous road crossings. All laterals are concrete lined, because their capacity is less than 50 cfs. A lateral turnout will be constructed into Twelve Mile Coulee for fish and wildlife at Lonesome Lake; also one lateral will provide water service for the town of Big Sandy.

Permanent operation and maintenance facilities to operate this route efficiently would involve construction of an office, shop, and garage in the town of Big Sandy. Another shop-garage building and equipment yard would be located in the Central Marias area.

Irrigation Benefits

NED Account. Benefits per acre (table 10), based on the Farm Budget Analysis (see appendix C, page 129) are computed at $45 per acre for supplemental service and $70 per acre for full service. Full service benefits ($70 per acre) are discounted by a development factor of 0.891. This discounting is necessary to compensate for the time necessary for the irrigator to adjust agricultural practices, techniques, and management to fully utilize the additional production potential. The development period is considered as a five-year period and the discount factor would provide for a six-month development allocation.


PROPOSED DIVERSION ROUTES
from LAKE ELWELL and
MISSOURI RIVER
N
Proposed Diversion Routes
Irrigated Land
Irrigable Land
Pumping Plant
Holding Reservoir
Miles
5 0 5 10
Milk River
Wild Horse Lake
232
Fresno Reservoir
Sage Creek
Chain of Lakes Coulee
Milk River
Joplin
Inverness
Rudyard
Hingham
Gildford
Kremlin
Havre
2
Chester
Route 1
Big Sandy Creek
87
Lake Elwell
Marias River
Box Elder
Lonesome Lake
Route 2
Route 1a
Big Sandy
ROCKY BOYS INDIAN RESERVATION
Missouri R.
Route 2 Pumping Plant
Virgelle
LIBERTY
HILL
CHOUTEAU

recommends this route (see appendix A). Of the four routes studied, it appears that this route has the most favorable impact on fish and wildlife game resources.

Proposed Engineering Plan

In order to release 1,500 cfs from Lake Elwell at the existing outlet tunnel, a 4,737-foot concrete-lined horseshoe tunnel, diameter 15 feet, will be located in the abutment of the dam. The outlet portal of this tunnel leads into the Marias-Milk Canal, (Route 1 direct to Fresno) extending 80.2 miles. Major structures consist of seven siphons (lengths ranging from 228 to 7,760 feet); a bifurcation structure for releasing water into the Big Sandy Canal; a fish filter or screen; 13 drops and a terminal drop into Fresno; numerous bridges for crossing; and 40 lateral and farm turnouts. Structures will include drainage inlets and cross drainage culverts. One lateral is constructed to divert water into Chain-of-Lakes Coulee for fish and game use. The upper end of all major structures will be equipped with appropriate protective and escape devices, such as safety nets and slope ladders to assist humans, livestock, and wild animals in escaping from the canal. Laterals required to serve irrigable lands from this canal range in capacity from 93 to 5 cfs. For estimating cost, concrete lining was assumed for all laterals with capacity of 50 cfs or less. Output into Fresno Reservoir is 400 cfs.

Big Sandy Canal, 64.2 miles long, with an initial capacity of 513 cfs and a terminal capacity of 15 cfs would require structures as follows: three siphons, 314-feet, 540-feet, and 17,410-feet long; three wasteways; one concrete chute, 1,330 feet long with three 8 x 7-feet radial gates; and numerous road crossings. All laterals are concrete lined, because their capacity is less than 50 cfs. A lateral turnout will be constructed into Twelve Mile Coulee for fish and wildlife at Lonesome Lake; also one lateral will provide water service for the town of Big Sandy.

Permanent operation and maintenance facilities to operate this route efficiently would involve construction of an office, shop, and garage in the town of Big Sandy. Another shop-garage building and equipment yard would be located in the Central Marias area.

Irrigation Benefits

NED Account. Benefits per acre (table 10), based on the Farm Budget Analysis (see appendix C, page 129) are computed at $45 per acre for supplemental service and $70 per acre for full service. Full service benefits ($70 per acre) are discounted by a development factor of 0.891. This discounting is necessary to compensate for the time necessary for the irrigator to adjust agricultural practices, techniques, and management to fully utilize the additional production potential. The development period is considered as a five-year period and the discount factor would provide for a six-month development allocation.

TABLE 10

NED ACCOUNT: MARIAS-MILK

FULL SERVICE:		
72,700 acres x $70/acre x 0.891 =		$4,534,299
SUPPLEMENTAL SERVICE:		
108,140 acres x $45/acre =		4,866,300
TOTAL ANNUAL BENEFITS		$9,400,599
	Rounded	$9,401,000

Many of the new acres cannot be irrigated by using flood and gravity techniques and will require sprinkler systems.

RD Account. The RD Account analysis is shown in table 11.

TABLE 11

RD ACCOUNT: MARIAS-MILK

Benefits		
Direct User Benefits		$ 9,401,000
Irrigation	$ 9,401,000	
Regional Benefits[a]		11,646,000
Employment	1,118,000	
Induced and Stemming	10,528,000	
TOTAL BENEFITS		$21,047,000
Costs		
Investment	$11,161,000	
OM&R	309,000	
TOTAL COSTS		$11,470,000
Net Benefits		$ 9,577,000
Benefit:Cost Ratio		1.83:1.00

[a] See appendix B.

Cost Estimates

Cost estimates for the facilities required for this route were based on the 1972 Marias-Milk Feasibility Report, prepared by the Bureau of Reclamation. All costs in this report were updated and indexed to January 1976 normalized price levels. A summary of the costs are included in table 12.

TABLE 12

COST ESTIMATES FOR ROUTE 1: MARIAS-MILK

Marias-Milk Canal		$ 71,747,000
Big Sandy Canal		22,002,000
Irrigation Facilities[a]		62,563,000
Permanent Operating Facilities		789,000
Fish and Wildlife Facilities		941,000
	TOTAL CONSTRUCTION COST	$158,042,000
Settlers Assistance Cost		538,000
	INSTALLATION COST	$158,580,000
Interest During Construction		23,170,000
	TOTAL PROJECT COST	$181,750,000
Amortization Factor[b]		.06141
Annual Equivalent Value		$ 11,161,000
Annual OM&R Costs[c]		309,000
	TOTAL (INVESTMENT AND OM&R)	$ 11,470,000
Benefit:Cost Ratio[d]		.84:1.00

a See appendix B.
b Based on an interest rate of 6 1/8%.
c Operations, Maintenance, and Replacement Costs.
d See appendix B.

Route 2: Virgelle - Havre

This route (see map 2, page 27) consists of a pump lift from the Missouri River near Virgelle and then gravity flow by canal roughly paralleling Big Sandy Creek to the Milk River. The canal, about 42 miles long, will serve 24,000 irrigable acres of new land along the route, as well as serving supplemental water to 108,140 acres along the mainstem. A regulation reservoir is planned near the junction of Big Sandy Creek and the Milk River primarily for holding in-canal volumes during flood stages and will have an outlet for releasing supplemental water into the Milk. During irrigation season the volume input of 170 cfs is not expected to cause appreciable alteration of the existing Milk River channel due to increased flows.

Proposed Engineering Plan

The pump station, near Virgelle on the Missouri River, has a capacity of 415 cfs to lift water 200 feet to a conveyance canal. The regulation reservoir will be constructed of zoned earthfill, approximately 70-feet high, and has a storage capacity of 16,000 acre-feet. Structures on the canal will include two siphons, each 0.25 to 0.5 miles long; a bifurcation structure for servicing 6,000 acres of irrigable land; numerous bridges and crossings; five drops; and lateral and farm turnouts. Structures will also include drainage inlets and cross drains. The upper end of major structures will be equipped with safety devices as mentioned for Route 1.

The pump site for this route lies in a reach of the Missouri River that has been designated as "wild and scenic" in accordance with P.L. 94-486 (94th Congress, October 12,1976); however, this law (title II, sec 203(e)) permits pumping facilities for agricultural use outside the river corridor.

Approximately 9,000 acres of irrigable land lies in the Virgelle Area, and a further pump lift of as much as 150 feet is needed for 3,000 of those acres. Fifteen thousand acres are in the Big Sandy area, and an additional lift of approximately 50 feet is needed for 6,000 acres of that land. Permanent operation and maintenance facilities to operate the unit efficiently will include an office, shop, and garage located in the town of Big Sandy.

Irrigation Benefits

NED Account. The same benefits per acre ($45 per acre supplemental and $70 per acre full service) were used in this alternative (table 13) as were used for Route 1. Refer to page 29 for explanatory information.

TABLE 13

NED ACCOUNT: VIRGELLE-HAVRE

FULL SERVICE:		
24,000 acres x $70/acre x 0.891 =		$1,496,880
SUPPLEMENTAL SERVICE:		
108,140 acres x $45/acre =		4,866,300
TOTAL ANNUAL BENEFITS		$6,363,180
	Rounded	$6,363,000

RD Account. The RD Account analysis is shown in table 14.

TABLE 14

RD ACCOUNT: VIRGELLE-HAVRE

Benefits		
Direct User Benefits		$6,363,000
Irrigation	$6,363,000	
Regional Benefits[a]		7,446,000
Employment	319,000	
Induced and Stemming	7,127,000	
TOTAL BENEFITS		$13,809,000
Costs		
Investment	$4,434,000	
OM&R	306,000	
TOTAL COSTS		$ 4,740,000
Net Benefits		$ 9,069,000
Benefit:Cost Ratio		2.91:1.00

a See appendix B.

Cost Estimates

Cost estimates for the facilities required for this route were based on the 1972 Marias-Milk Feasibility Report, prepared by the Bureau of Reclamation. All costs in this report were updated and indexed to January 1976 normalized price levels. A summary of the costs are included in table 15.

TABLE 15

COST ESTIMATES FOR ROUTE 2: VIRGELLE-HAVRE

Virgelle Pumping Plant		$ 7,600,000
Virgelle-Havre Canal		12,300,000
Regulation Demand Reservoir		6,700,000
Irrigation Facilities[a]		37,330,000
Permanent Operating Facilities		325,000
	TOTAL CONSTRUCTION COST	$64,255,000
Settlers Assistance Cost		175,000
	INSTALLATION COST	$64,430,000
Interest During Construction		7,780,000
	TOTAL PROJECT COST	$72,210,000
Amortization Factor[b]		.06141
Annual Equivalent Value		$ 4,434,416
Annual OM&R Costs[c]		306,100
	TOTAL (INVESTMENT AND OM&R)	$ 4,740,516
Benefit:Cost Ratio[d]		1.34:1.00

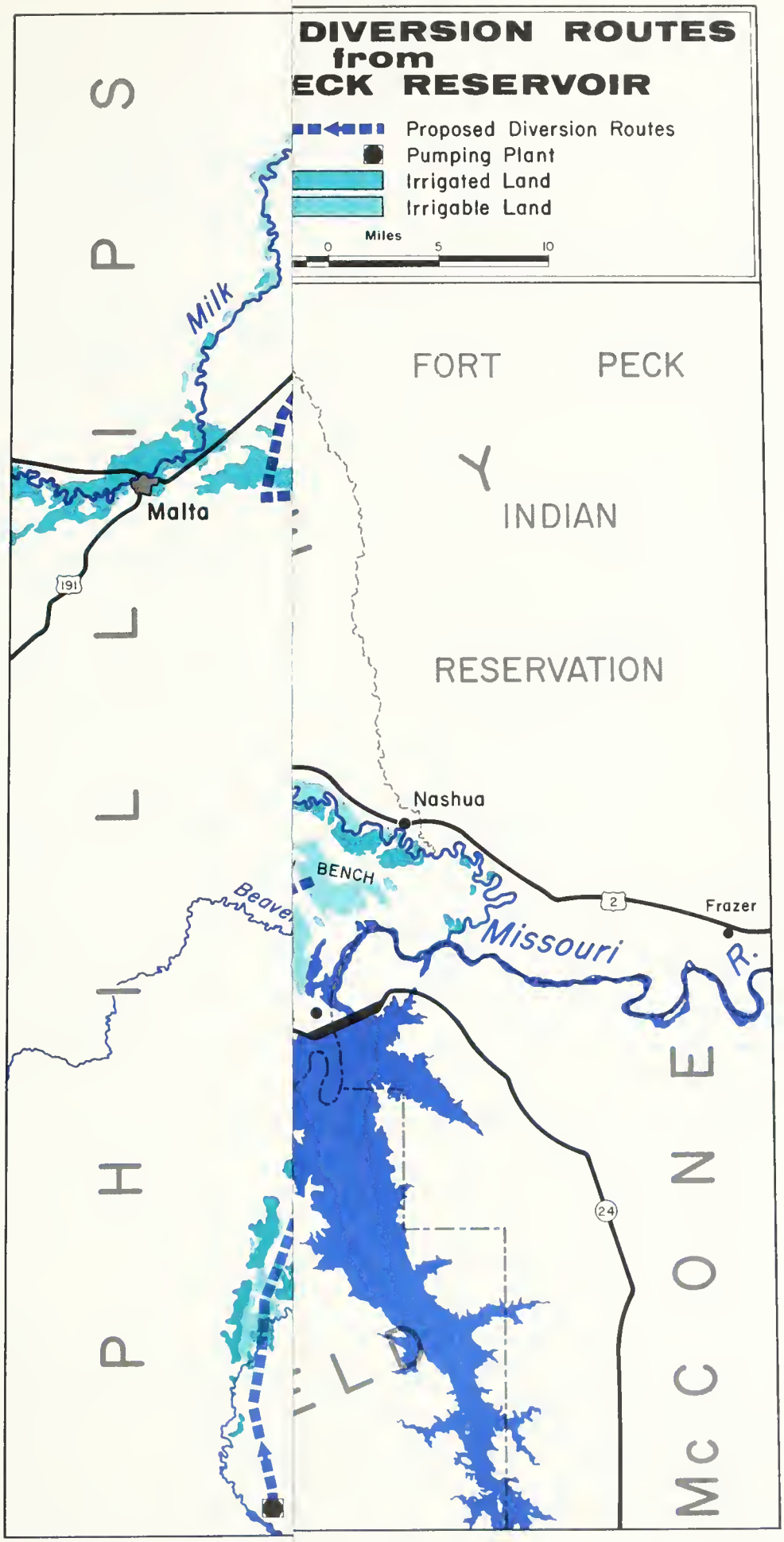
a See appendix B.
b Based on an interest rate of 6 1/8%.
c Operations, Maintenance, and Replacement Costs.
d See appendix B.

Route 3: Telegraph Creek - Beaver Creek

This route, a pump lift from the Telegraph Creek Arm, Fort Peck Reservoir, and then gravity flow to Nelson Reservoir, via a canal 60 miles long, roughly parallels Telegraph Creek and Beaver Creek (see map 3, page 35). Approximately 2,000 acres of new land can be served enroute to the Milk River by gravity irrigation. Along this route, there are the least number of irrigable acres. The point of diversion is on the UL Game Refuge, and a part of the route crosses the C.M. Russell National Wildlife Range. Both the Montana Department of Fish and Game, (see appendix A) and the U.S. Bureau of Sport Fisheries and Wildlife can see beneficial aspects for wildlife for this route, at the UL Refuge and at Lake Bowdoin. In the event this route is chosen, right of way across the C.M. Russell National Wildlife Range must be secured, in addition to rights of way across private land.

Proposed Engineering Plan

A pumping plant of 240 cfs capacity will lift water 180 feet from Fort Peck Reservoir near the mouth of Telegraph Creek; included in the lift is accommodation for a possible 70-foot drawdown on the reservoir. Output capacity is 180 cfs into Nelson South Feeder Canal; approximately 14 miles of this canal will be enlarged. Major structures will consist of one siphon, a mile long; numerous bridges for crossing; lateral and terminal turnouts; and drainage inlets and cross drains. The upper end of major structures will be equipped with safety devices as mentioned for previous routes.


DIVERSION ROUTES
from
ECK RESERVOIR
Proposed Diversion Routes
Pumping Plant
Irrigated Land
Irrigable Land
Miles
0
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PHILLIPS
Milk
Malta
191
FORT PECK
INDIAN
RESERVATION
Nashua
BENCH
Beaver
2
Frazer
Missouri
R.
24
McCONE
ELD

Irrigation Benefits

NED Account. The same benefits per acre ($45 per acre supplemental and $70 per acre full service) were used in this alternative (table 16) as was used for Route 1. Refer to page 29 for explanatory information.

TABLE 16

NED ACCOUNT: TELEGRAPH CREEK - BEAVER CREEK

FULL SERVICE:		
2,000 acres x $70/acre x 0.891 =		$ 124,740
SUPPLEMENTAL SERVICE:		
108,140 acres x $45/acre =		$4,866,300
TOTAL ANNUAL BENEFITS		$4,991,040
	Rounded	$4,991,000

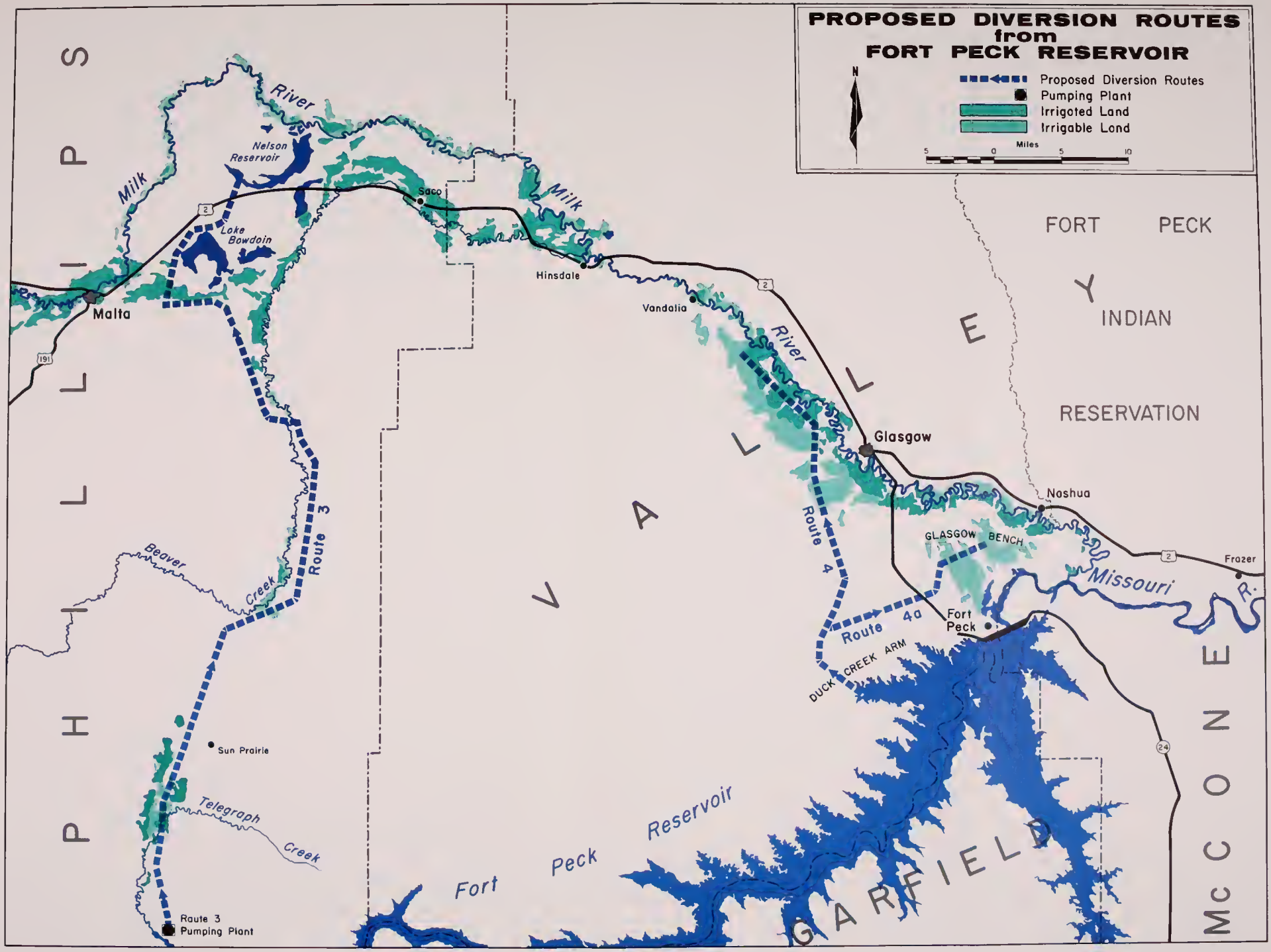
RD Account. The RD Account analysis is shown in table 17.

TABLE 17

RD ACCOUNT: TELEGRAPH CREEK - BEAVER CREEK

Benefits		
Direct User Benefits		$ 4,991,000
Irrigation	$4,991,000	
Regional Benefits[a]		5,803,000
Employment	213,000	
Induced and Stemming	5,590,000	
TOTAL BENEFITS		$10,794,000
Costs		
Investment	$ 2,149,000	
OM&R	154,800	
TOTAL COSTS		$ 2,303,800
Net Benefits		$ 8,490,200
Benefit:Cost Ratio		4.69:1.00

a See appendix B.


PROPOSED DIVERSION ROUTES
from
FORT PECK RESERVOIR
N
Proposed Diversion Routes
Pumping Plant
Irrigated Land
Irrigable Land
Miles
5 0 5 10
PHILLIPS
VALLEY
McCONE
GARFIELD
FORT PECK
INDIAN
RESERVATION
Milk River
Nelson Reservoir
Lake Bowdoin
Malta
Saco
Hinsdale
Vandalia
Milk River
Glasgow
Nashua
Frazer
Missouri R.
GLASGOW BENCH
Fort Peck
DUCK CREEK ARM
Route 4
Route 4a
Route 3
Beaver Creek
Sun Prairie
Telegraph Creek
Fort Peck Reservoir
Route 3
Pumping Plant
191
2
24

Irrigation Benefits

NED Account. The same benefits per acre ($45 per acre supplemental and $70 per acre full service) were used in this alternative (table 16) as was used for Route 1. Refer to page 29 for explanatory information.

TABLE 16

NED ACCOUNT: TELEGRAPH CREEK - BEAVER CREEK

FULL SERVICE:		
2,000 acres x $70/acre x 0.891 =		$ 124,740
SUPPLEMENTAL SERVICE:		
108,140 acres x $45/acre =		$4,866,300
TOTAL ANNUAL BENEFITS		$4,991,040
	Rounded	$4,991,000

RD Account. The RD Account analysis is shown in table 17.

TABLE 17

RD ACCOUNT: TELEGRAPH CREEK - BEAVER CREEK

Benefits		
Direct User Benefits		$ 4,991,000
Irrigation	$4,991,000	
Regional Benefits[a]		5,803,000
Employment	213,000	
Induced and Stemming	5,590,000	
TOTAL BENEFITS		$10,794,000
Costs		
Investment	$ 2,149,000	
OM&R	154,800	
TOTAL COSTS		$ 2,303,800
Net Benefits		$ 8,490,200
Benefit:Cost Ratio		4.69:1.00

a See appendix B.

Cost Estimates

Cost estimates for the facilities required for this route were based on the 1972 Marias-Milk Feasibility Report, prepared by the Bureau of Reclamation. All costs in this report were updated and indexed to January 1976 normalized price levels. A summary of the costs are included in table 18.

TABLE 18

COST ESTIMATES FOR ROUTE 3: TELEGRAPH CREEK - BEAVER CREEK

Telegraph Creek Pumping Plant		$ 4,620,000
Deferred Waterways Pumping Plant		1,340,000
Telegraph Creek-Beaver Creek Canal		18,570,000
Nelson Feeder Canal Enlargement		1,800,000
Irrigation Facilities[a]		3,200,000
Transmission Lines		1,690,000
	TOTAL CONSTRUCTION COST	$31,220,000
Interest During Construction		3,774,000
	TOTAL PROJECT COST	$34,994,000
Amortization Factor[b]		.06141
Annual Equivalent Value		$ 2,149,000
Annual OM&R Costs[c]		154,800
	TOTAL (INVESTMENT AND OM&R)	$ 2,303,800
Benefit:Cost Ratio[d]		2.17:1.00

a See appendix B.
b Based on an interest rate of 6 1/8%.
c Operations, Maintenance, and Replacement Costs.
d See appendix B.

Route 4: Duck Creek - Vandalia

This route from the Duck Creek Arm, Fort Peck Reservoir, northward to the Glasgow-Vandalia Canal can also serve irrigable acres on the Glasgow bench (see map 3, page 35). This canal, approximately 31 miles long is a gravity flow channel, 90-100 feet deep (maximum cut). In the Vandalia area, some 19,000 acres of new land can be irrigated; 18,000 acres of existing irrigated lands can be fully serviced. Also, 700 acres of new land could be serviced by relift, in addition to 8,000 irrigable acres on Glasgow bench, which can be fully served. Outlet of the canal is in the existing canal system. Initial capacity is 650 cfs, which includes diversion requirements for Glasgow bench, and terminal flow is 170 cfs.

Safety structures are planned as described for Route 1. A future pumping plant is included in the economic estimate in the event Fort Peck Reservoir should change to a lower operating level.

The canal inlet and part of the route lies on C.M. Russell National Wildlife Range, controlled by the U.S. Fish and Wildlife Service. Officials of this agency have stated that a structure across the Range would have to benefit wildlife. No benefits have been discovered; in fact, a deep canal can adversely affect the area wildlife (appendix A).

Irrigation Benefits

NED Account. The same benefits per acre ($45 per acre supplemental and $70 per acre full service) were used in this alternative (table 19) as was used for Route 1. Refer to page 29 for explanatory information.

TABLE 19

NED ACCOUNT: DUCK CREEK - VANDALIA

FULL SERVICE:	
19,000 acres x $70/acre x 0.891 =	$1,185,000
SUPPLEMENTAL SERVICE:	
53,200 x $45/acre =	2,394,000
TOTAL ANNUAL BENEFITS	$3,579,000

RD Account. The RD Account analysis is shown in table 20.

TABLE 20

RD ACCOUNT: DUCK CREEK - VANDALIA

Benefits		
Direct User Benefits		$3,579,000
Irrigation	$3,579,000	
Regional Benefits		4,369,000
Employment	361,000	
Induced and Stemming	4,008,000	
TOTAL BENEFITS		$7,948,000
Costs		
Investment	$3,353,723	
OM&R	177,700	
TOTAL COSTS		$3,531,422
Net Benefits		$4,416,578
Benefit:Cost Ratio		2.25:1.00

Cost Estimates

Cost estimates for the facilities required for this route were based on the 1972 Marias-Milk Feasibility Report, prepared by the Bureau of Reclamation. All costs in this report were updated and indexed to January 1976 normalized price levels. A summary of the costs are included in table 21.

TABLE 21

COST ESTIMATES FOR ROUTE 4: DUCK CREEK - VANDALIA

Duck Creek Pumping Plant		$ 5,000,000
Duck Creek-Vandalia Canal		23,000,000
Irrigation Facilities[a]		20,180,000
Transmission Lines		360,000
	TOTAL CONSTRUCTION COST	$48,540,000
Settlers Assistance		140,000
	INSTALLATION COST	$48,680,000
Interest During Construction		5,932,000
	TOTAL PROJECT COST	$54,612,000
Amortization Factor[b]		.06141
Annual Equivalent Value		$ 3,353,722
Annual OM&R[c]		177,700
	TOTAL (INVESTMENT AND OM&R)[d]	$ 3,531,422
Benefit:Cost Ratio[e]		1.01:1.00

a See appendix B.
b Based on an interest rate of 6 1/8%.
c Operations, Maintenance, and Replacement Costs.
d The total cost was computed using nondeferred construction of the Duck Creek pumping plant.
e See appendix B.

PART II
STREAMFLOW

The Milk River watershed, with a drainage area of 22,332 square miles, originates in Glacier County close to the United States-Canadian border. The river flows from the United States through Canada for approximately 215 miles before reentering the United States approximately 20 miles upstream of Fresno Reservoir.

The St. Mary River in the United States has a total drainage area of 469 square miles, deriving its water from the mountains of Glacier National Park in Glacier County as well as a portion of the Blackfeet Indian Reservation.

These rivers as well as the major tributaries and the St. Mary Canal are shown on map 1, page 7.

St. Mary River

A discussion of the St. Mary River drainage is included because of the interbasin transfer of water that occurs annually via the St. Mary canal. To supplement the Milk River flows during the irrigation season, part of the St. Mary River flow is diverted to the North Fork Milk River via the canal near Babb, Montana. The allocation of the waters of the two rivers between the United States and Canada is governed by the Boundary Waters Treaty of 1909.

During the irrigation season, the United States' share of the natural flow of the St. Mary River at the International Boundary, as stipulated by the IJC's 1921 Amendment to Article VI, is to be 25 percent of the natural flow up to a total flow of 666 cfs, with anything above that quantity to be divided equally between Canada and the United States. During the non-irrigation season (November 1 to March 31), the entire natural flow is to be divided equally between the two countries.

Computations are not made during the non-irrigation season as the only usage by the United States during this period is storage in Lake Sherburne. The average annual flow into this reservoir is only about 25 percent of the total natural flow at the International Boundary.

Lake Sherburne, the only storage reservoir in the St. Mary River Basin in the United States, is used to store excess flows for diversion to the Milk River. This water, after passing through Canada, is utilized by the United States for irrigation in the lower Milk River valley. This water is not subjected to the allocation formula that is applied to the Milk River.

Water is diverted from the St. Mary River to the North Fork Milk River via the St. Mary Canal from March through September on a normal operating year. March, however, is considered to be in the non-irrigation season, and therefore, the diversion for this month has to be computed on an equal share basis. The average annual irrigation season recorded flow for a 58-year period of record (1918-1975) at the gauging station on the St. Mary Canal at St. Mary Crossing is 140,457 acre-feet.

The average discharge of the St. Mary River at the International Boundary for the 15-year period (1902-1916), prior to the operation of the St. Mary Canal was 726,700 acre-feet per year; for the 60-year period (1916-1975), the average flow was 513,700 acre-feet per year.

Milk River

The 1931 Amendment to Article VI on the division of flow of the Milk River is the converse of that for the St. Mary River. During the irrigation season, the United States is entitled to 75 percent of the flow up to a total discharge of 666 cfs, with any amount above this total to be divided equally between the two countries. During the non-irrigation season (November 1 to March 31), the entire flow is to be divided equally.

The computed natural flow of the Milk River at its Eastern Crossing of the International Boundary during the 63-year period of record from 1912-1974 was 116,420 acre-feet. The United States and Canadian shares were 77,546 and 38,874 acre-feet respectively. These figures are based on a seven-month period from April 1 through October 31.

The U. S. Geological Survey has maintained streamflow gauging stations at several points along the Milk River (table 22).

TABLE 22

MILK RIVER GAUGING STATIONS

Location	Station Number	Years of Record
Western Crossing, International Boundary	06133000	1931 - present
Eastern Crossing, International Boundary	06135000	1909 - present
Havre	06140500	1899 - 1922 1954 - present
Lohman	06143000	1951 - 1952
Harlem	06154100	1959 - 1959
Malta	06155500	1902 - 1922
Vandalia	06172000	1915 - 1939 1969 - 1973
Tampico	06172310	1973 - 1974
Nashua	06174500	1939 - present

Records are maintained from March through September at some stations and yearly at Havre and Nashua. Flow is augmented, during irrigation season, by diversion from St. Mary River into the North Fork Milk River, upstream from Western Crossing at the United States-Canada border. Records for the period 1961 to 1973 indicate a highly variable flow during irrigation season (table 23).

TABLE 23

MILK RIVER FLOW RECORDS, 1961-1973

Gauging Station	Low Monthly Flow	High Monthly Flow
Eastern Crossing	4,740 af, September 1973	107,700 af, May 1967
Havre	7,980 af, April 1973	134,700 af, May 1967
Nashua	889 af, June 1961	361,200 af, April 1969

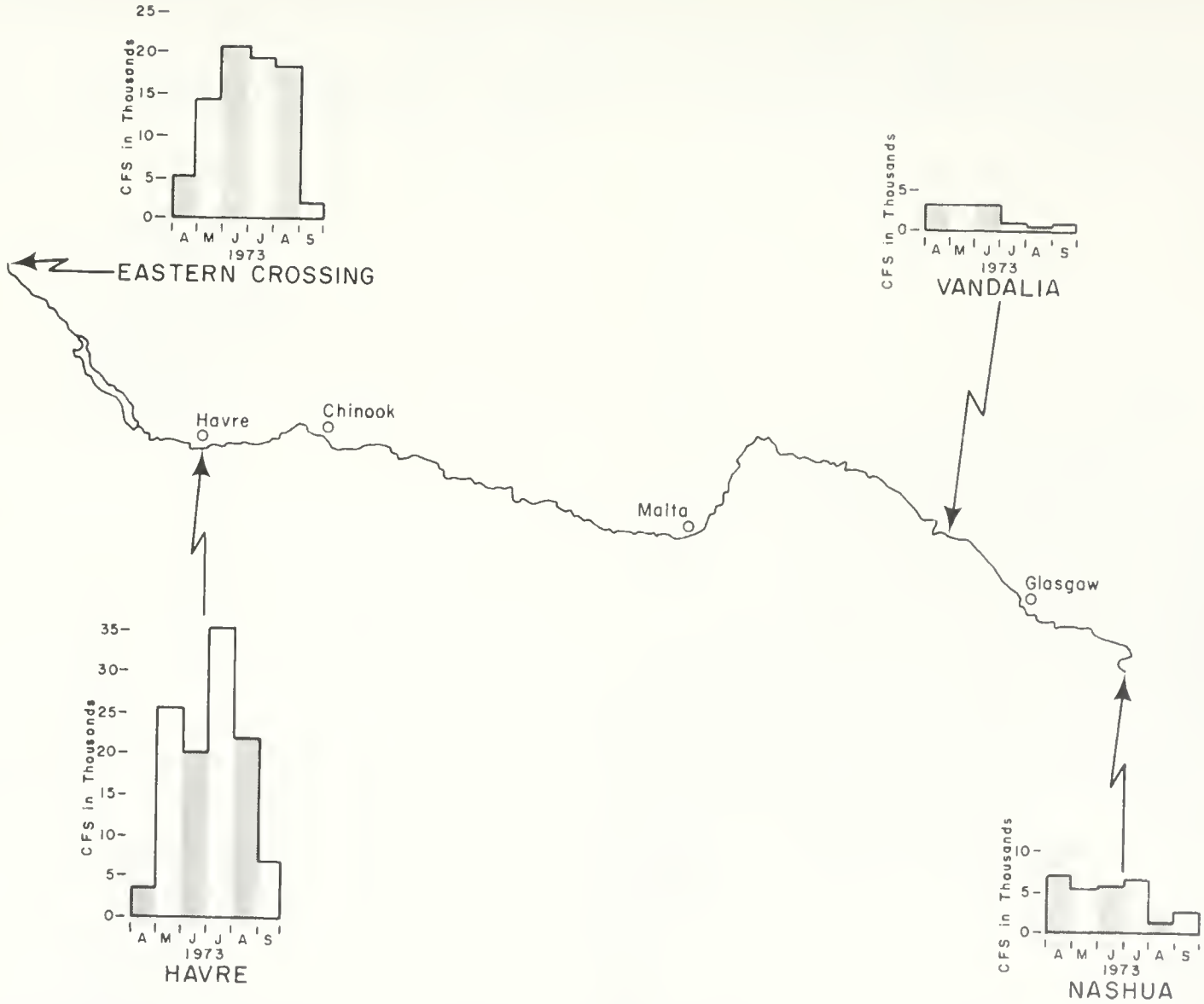
Ten miles upstream from Havre, flow is controlled by storage and/or release from Fresno Reservoir. At points further downstream, flow is altered by irrigation diversion sites or by offstream storage areas and augmented by several tributaries as well as return flows.

Stream gauge records were studied for the period 1961 to 1973, when they were most complete. The year 1973 was the driest of the period; figure 2 shows monthly flow (April through September) for this year. It should be noted that the flow is much less at Vandalia and Nashua than at Havre even though several tributaries enter downstream from Havre. A possible reason for this is the extensive irrigation between Havre and Nashua. During high flow years, there is little, if any, loss. Figures 2 and 3 show flows for a dry season and a wet season. Figure 4 shows measured flow at Eastern Crossing if Canada has utilized its portion.

In the future, the Province of Alberta might exercise its full rights to the water in the river, which it has not done in the past; shortages during past dry years will be amplified in future similar dry years. According to the terms of the Boundary Waters Treaty and Amendment, at Eastern Crossing the United States is allocated 75 percent of the flow up to and including 666 cfs; flow greater than that is divided equally. Thus during times of high flow, the division is about equal. The accompanying graph (figure 5) provides a quick guide to the percentage of flow belonging to the United States at given flow peaks at Eastern Crossing according to the Treaty. It must be stressed that this flow is available to Fresno Reservoir, which modifies flow downstream. Thus, from the graph, for example, if the measured flow is predicted to be 20,000 cfs, then 50 percent (10,000 cfs) would be available to the United States; if the flow is predicted at 2,000 cfs, then approximately 58 percent (1,166 cfs) would be available.

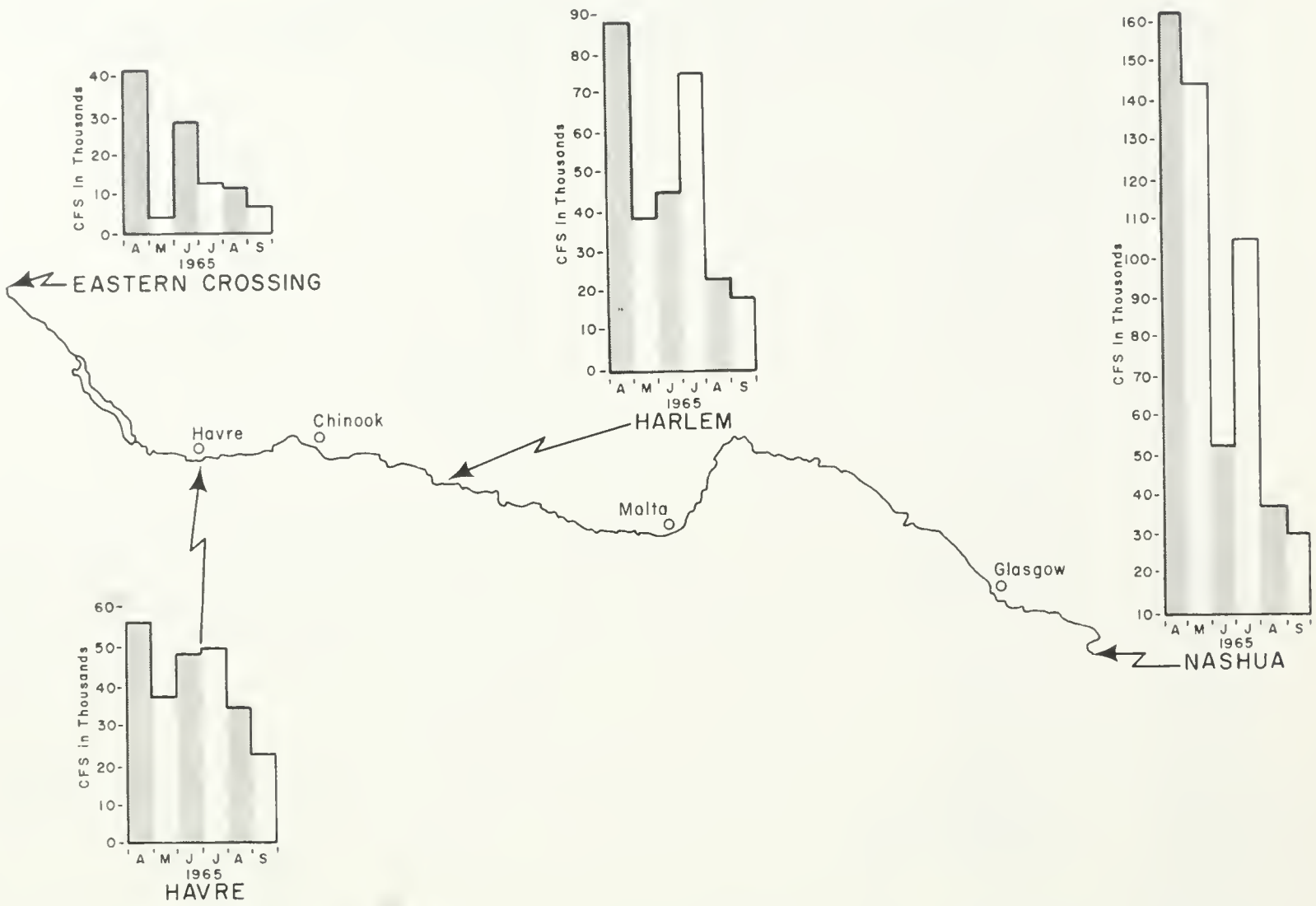
The Bureau of Reclamation has studied the water supply in the Milk River Basin and has determined that the average annual shortage (1964-73) was 38,000 acre-feet. 1973 was the maximum shortage year with 31 percent shortage. If Canada had used its legal allotments, the annual shortage would have been 49,200 acre-feet for this ten-year period.

From this discussion it is apparent that there has been and will continue to be a shortage of water in the basin, especially in the lower reaches. More use by Canada, the possibility of a larger water grant for the Fort Belknap Reservation, and development of more irrigated lands will contribute to the shortage. Increased water supplies of the amount necessary to alleviate existing shortages depend on import into the basin from other streams.



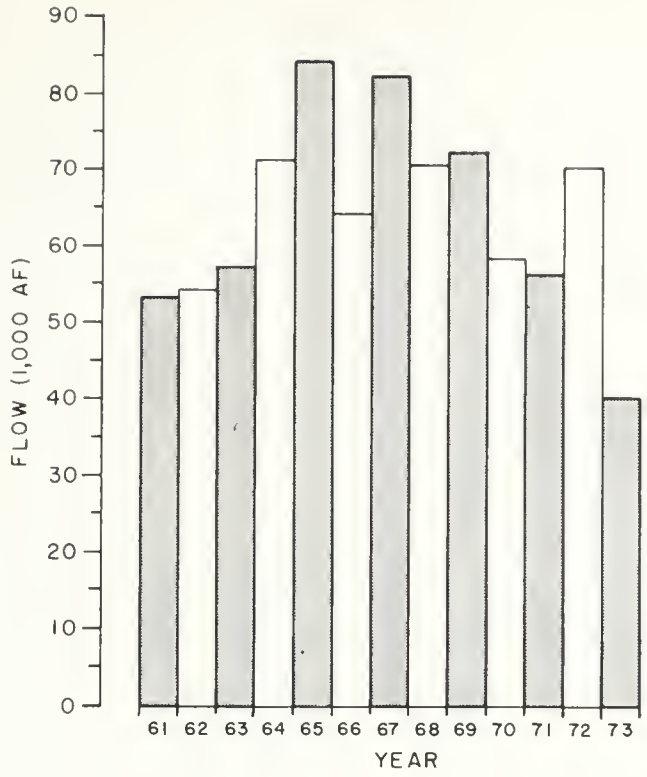
MEASURED MONTHLY IRRIGATION SEASON FLOW ON MILK RIVER FOR A LOW FLOW YEAR, 1973

Figure 2



MEASURED MONTHLY IRRIGATION SEASON FLOW ON MILK RIVER FOR A HIGH FLOW YEAR, 1965

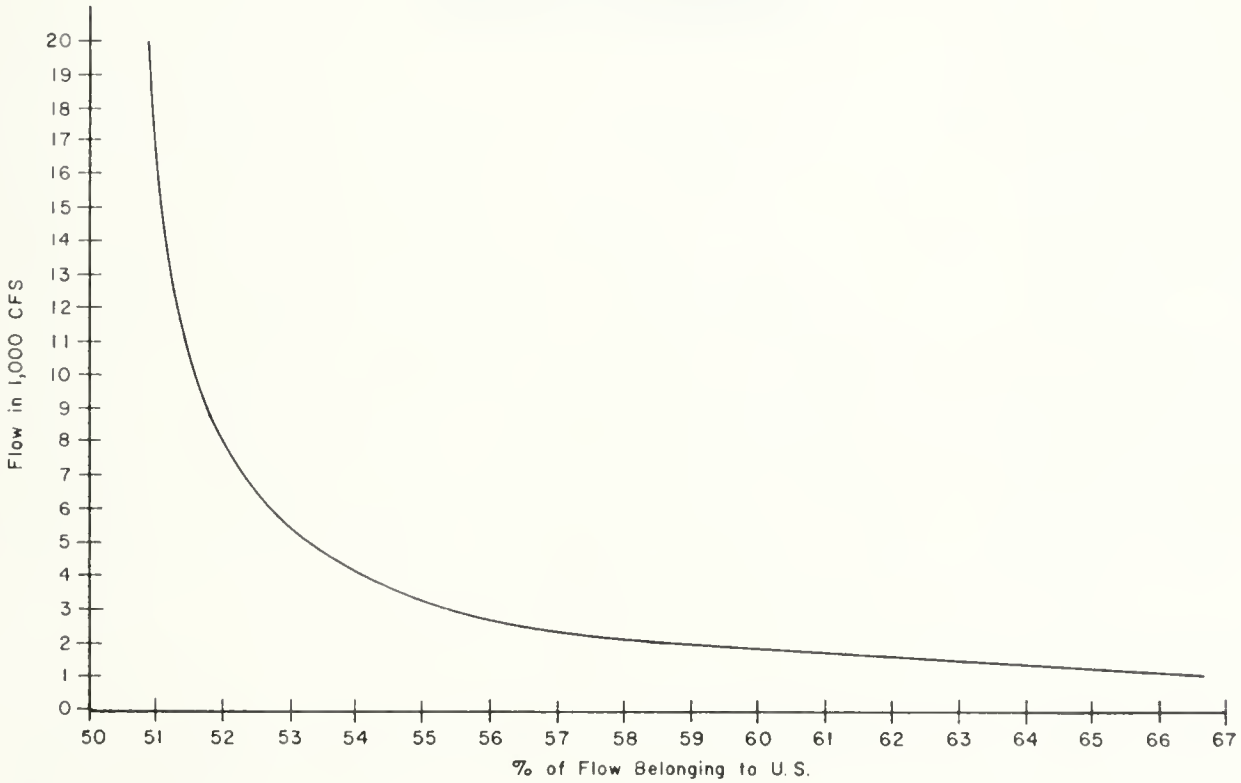
Figure 3



Flow during irrigation season, direct gauge reading

MILK RIVER FLOW AT EASTERN CROSSING

Figure 4



PERCENTAGE OF MILK RIVER FLOW AT EASTERN CROSSING
WHICH BELONGS TO THE UNITED STATES

Figure 5

PART III
WATER AVAILABILITY ANALYSIS

Inflows, releases from Fresno Reservoir, and existing diversions were assessed to determine the water availability situation of the study area. The basic operating criteria determining releases and diversions of water are as follows:

1. Fresno Reservoir operates with a maximum conservation storage of 127,228 acre-feet. For flood control purposes, storage on March 1 is recommended not to exceed 85,000 acre-feet. A release of 40 cfs is made to satisfy municipal and other uses downstream.

2. Demands upon Fresno Reservoir are scheduled by the irrigation districts or diversions.

3. Nelson Reservoir is filled in the spring to meet demands of Nelson South Canal; its maximum conservation storage is 58,000 acre-feet.

4. Municipal water is pumped from Fresno Reservoir for Hill County Water District, and downstream towns receive direct diversions.

5. An annual diversion for fish and wildlife habitat is made to Lake Bowdoin.

The flows at the Eastern Crossing now represent the United States share of the Milk River as well as the Canadian share and the diversion from the St. Mary River. For this analysis it was assumed that the Canadians would deplete their share of the Milk River. An operation study generating this inflow for the period 1927 to 1960 was done for the Marias-Milk Unit Water Supply Report. This operation study used only the portion of historical runoff in the Milk and St. Mary rivers that is the United States' share by treaty; this is published by the International Joint Commission, St. Mary-Milk Division. The inflow to Fresno Reservoir for the remaining period 1961 through 1974 was generated by adding the United States' share of natural flow of the Milk River to the historic diversions of St. Mary Canal near Babb, and canal losses were subtracted.

Historic runoff records for major tributaries flowing into the Milk River are gauged at sites near the United States-Canada boundary. For determining inflow to the Milk River, the flows were depleted for existing downstream irrigation.

Operation Study Results

The operation study was made using the generated inflow to Fresno Reservoir for the period 1927 to 1973. It showed that the average annual shortage would

be 51,500 acre-feet when Canada fully develops its share of Milk River water. For the years 1964 through 1973 the average annual shortage was 49,200 acre-feet. This same study showed that a shortage of 61 percent occurred in the maximum short year 1941, and for the 10-year period, 1936 to 1945, the total of all annual percent shortages is 294 percent. In 1941 the actual diversion was 1.36 acre-feet per acre, considerably less than the 3.5 acre-feet per acre projected diversion requirement. For the 10-year period, 1936 to 1945, the average actual diversion requirement was 2.47 acre-feet per acre, still less than the projected 3.5 acre-feet per diversion requirement.

After determining what shortages exist in the basins, other studies were run that introduced supplemental flows to the river. The results of these computer runs follow:

For the Marias-Milk Route, the operation study brought supplemental flow into the Milk River at the Chain-of-Lakes using a 370 cfs canal plus return flows from the Marias-Big Sandy lands. The operation study indicated that the preceding shortages could be met.

For the Virgelle Route, the supplemental flow needed to meet the shortage criteria and provide a sull water supply is 18,000 acre-feet during the peak-use month and an average of 56,000 acre-feet annually. A small retaining reservoir at Havre was added to the diversion scheme in order to reduce the inflow canal size. The storage reservoir was designed for 16,000 acre-feet conservation storage, and the canal was designed to bring in 10,000 acre-feet monthly, giving it the capacity to meet the peak demand of 18,000 acre-feet for two months of the year.

For the Telegraph Creek Route, supplemental inflow into Nelson Reservoir provided a full water supply to the Milk River lands. The inflow needed was 10,800 acre-feet during the maximum use month and an average of 63,000 acre-feet annually. The supplemental inflow canal joins Dodson South Canal at the junction of the Nelson Feeder Canal and the Bowdoin Canal. This supplemental inflow helped serve approximately 6,300 acres along Bowdoin Canal, all of the Nelson South area, and the Vandalia Area.

The operation study of the Vandalia Route introduces a supplemental inflow of 15,800 acre-feet monthly and an average of 63,000 acre-feet annually. This flow, which completely serves the 18,000 acres in the Vandalia area, left shortages in all of the lands above Vandalia. Because of these large shortages, a second operation study was made that would pump return flows out of the Milk River north of Nelson Reservoir and into Nelson South Canal. Outlined below are the resultant shortages and actual diversions for the two operation studies:

1. Study without return flow pumping:

    a. The average annual shortage was 34,900 acre-feet.

    b. The maximum shortage year 1941 showed an annual shortage of 57 percent.

    c. For the critical 10-year period, 1936 to 1945, accumulative shortages equaled 288 percent.

d. The actual diversion for the year 1941 was 1.51 acre-feet per acre when the full use for crops was 3.5 acre-feet per acre.

e. The average of the actual diversion for the critical period was 2.56 acre-feet per acre with 5 of the 10 years greater than 2.56.

2. Study with return flow pumping:

a. The average annual shortage was 24,500 acre-feet.

b. The maximum shortage year 1941 showed an annual shortage of 49 percent.

c. For the critical 10-year period, 1936 to 1945, accumulative shortages equaled 212 percent.

d. The actual diversion requirement for the year 1941 was 1.77 acre-feet per acre when the full use for crops was 3.5 acre-feet per acre.

e. The average of the actual diversion requirements for the critical period was 2.75 acre-feet per acre with 5 of the 10 years greater than 2.75.

PART IV
STORAGE

Storage Using Milk River Water

Fresno Dam, completed in 1939, is the major development on the river. Reservoir capacity is 129,000 acre-feet. Purposes for the impoundment are fish and wildlife, recreation, municipal and industrial, irrigation, and flood control.

The Fort Belknap Diversion Dam is adjacent to the Indian Reservation Agency Headquarters some three miles south of Harlem. Water from this site is used for irrigation.

The Dodson Diversion Dam, completed in 1910, serves as a source of irrigation water, impounding some 1,450 acre-feet.

Nelson Dam and Reservoir, completed in 1922, is an off-stream storage site of the Milk River, the water being used for irrigation, fish and wildlife, and recreation. Its capacity is 85,500 acre-feet.

Lake Bowdoin, a fish and game refuge, gets part of its water from the Dodson South Canal.

Vandalia Dam and Diversion, completed in 1917, serves irrigators through a system of canals and has a reservoir capacity of approximately 1,000 acre-feet.

There are also a large number of small dams and diversions on the tributaties. Total storage in these small reservoirs is 42,952 acre-feet and when coupled with the above major storage results in a total of 259,902 acre-feet of storage. A number of pumping stations are located on the river.

Storage Using Tributary Water

Beaver Creek Reservoir in Hill County has a capacity of 7,230 acre-feet, including 927 acre-feet for supplemental irrigation, and has supplemental irrigation and flood prevention storage of 2,185 acre-feet. The remainder is for fish and game, recreation, and additional flood storage.

A Preliminary Survey Report on the North Central Conservancy District (1970) listed 13 potential storage sites on Milk River tributaries as worthy of further study. These are:

1. Chouteau County, Big Sandy Creek

2. Chouteau County, Lonesome Lake

3. Hill County, Sage Creek

4. Hill County, Big Sandy Creek

5. Hill County, Little Box Elder Creek

6. Hill County, Beaver Creek (completed in 1974)

7. Hill County, Lodge Creek

8. Blaine County, Battle Creek

9. Blaine County, Savoy Creek

10. Phillips County, Beaver Creek

11. Phillips County, Whitewater Creek

12. Valley County, Rock Creek

13. Valley County, Willow Creek

Most of these projects were proposed in the early 1930's; some have been studied since then.

PART V
WATER RIGHTS

The Water Use Act

The Montana Water Use Act, the statutory foundation of the state's water law, became effective July 1, 1973. Objectives of the Act were three: (1) to institute a permit system for the appropriation of surface and ground water in Montana; (2) to provide a procedure for the legal determination of all existing water rights; and (3) to establish a system of centralized records of all water rights in the state. The Act is administered by the Department of Natural Resources and Conservation in Helena.

Prior to adoption of the Water Use Act in 1973, water rights could be obtained by various methods. One such method was to simply apply the water to a beneficial use, thus establishing what is referred to as a "use" right. A second way was to file a written notice with the Clerk and Recorder of the county in which the water was to be appropriated ("filed" right). And lastly, water rights could be established as a result of formal proceedings conducted in the courtroom; these "decreed" rights were binding only until someone who wished to obtain additional rights on the decreed stream petitioned the court to commence proceedings anew.

Existing Rights

Until the Milk River Basin is adjudicated pursuant to the Water Use Act, there is no way to determine the number or validity of water rights within the basin. A recent study conducted by department personnel includes an estimate of 68,850 cfs as the total flow filed upon from the Milk River proper. This estimate is based on the evaluation of available information on filed rights and decreed rights on the mainstem of the river. The amount of water actually being beneficially used pursuant to these filed rights is, however, impossible to estimate, as many projects were not completed to the extent indicated on the filings. Similarly, until adjudication, there is no way to quantify appropriations made via use rights, nor is it possible to determine periods of use for either filed rights or use rights. In short, although the Milk River waters appear to be very heavily appropriated, the Department is unable, at this time, to know which rights are valid and how much water is appropriated in the Milk River Basin.

The Permit System

Some insight into the current water rights situation in the Milk River Basin can be gained by analyzing the water rights applications submitted to the Department in the basin since July 1, 1973. One of the objectives of the Water Use Act was to institute a permit system for the appropriation of Montana waters.

Under the permit system, one who wishes to obtain a new water right must file an application with the Department. Notice of the application is then given by the Department to potentially affected water users and to newspapers in the basin, in order that possessors of earlier water rights may object if they feel that the application presents a potential adverse effect on their rights. If objections to the application are received, and if a settlement between objectors and applicant cannot be reached informally, then an administrative hearing is held to determine the outcome of the application. The necessity of conducting such hearings is usually an indication that the water supply in the source is insufficient. The Milk River Basin is one in which hearings are commonplace. Thus, the general availability of water for further appropriation requires careful consideration of each application with regard to proposed period of diversion, potential effect on prior rights, and increased depletion of the source.

Permits in the Milk River Basin

The result of a typical hearing in the Milk River Basin has been modification of the original application. Because most water use in the basin occurs during the irrigation season, and, simultaneously, the dry period of the year, applications for water withdrawal in July, August, and September are met with strong protest. The consensus among water users in the basin is that water for new appropriations during these months is simply not available. The Bureau of Reclamation, for example, has contended that ". . . some of the 'excess' water in the Milk River should not be considered available for appropriation. A portion of any 'excess' flow is the presently unused Canadian share of the natural flow of Milk River . . . under terms of the 1909 Boundary Waters Treaty." Because of the evidence presented at the hearings, then, the applications have been modified to allow appropriation of water only during the spring runoff period or during the off-irrigation season.

Justification for the Department's policy of modifying permits can be seen in a study done in 1970 by the engineering firm of Henningson, Durham, and Richardson for the North Central (Montana) Water Conservancy District. In this publication, the authors wrote, in a discussion of water availability in the Milk River Basin, that

> . . . analysis of the data . . . indicates that although flows are highly variable, an average flow of 523,400 acre-feet/year is available in the Milk River at Nashua (at the mouth of the river). Although an average of 523,400 acre-feet/year of water passes Nashua each year, the Bureau of Reclamation has indicated that existing storage in Fresno Reservoir and flow supplied from the St. Mary River is fully developed at the present time. In general, it would appear that water is available at times when it is not needed and is not available when needed.

Availability Versus Demand

The number of Milk River Basin water rights hearings and the substance of these hearings are, to date, the only criteria by which one can compare the availability of water in the drainage with the demand for the water by users in

the basin. The frequency of hearings in the basin indicates an anxious concern by water users about additional appropriations in the drainage. As for substance, most hearings reflect objectors' testimonies (in the form of flow figures, river and structure gauging records, etc.) which emphasize the inability of the basin to produce sufficient water to satisfy present rights. Upon analyzing such testimony, the Department has modified applications so that diversion will occur during noncritical periods of the year and issues permits subject to the following additional conditions:

1. Any final determination of existing water rights, as provided by Montana law.

2. The permanent installation of an adequate drainage device, channel, or any other necessary means to satisfy existing water rights.

3. All prior Indian reserved water rights in the source of supply.

4. All prior existing water rights in the source of supply.

Water Rights and Interbasin Transfer of Water

Any plan and subsequent project to divert water from an outside source to the Milk River Basin must necessarily involve new water rights. The Water Use Act requires that new water rights be obtained by the party which intends to divert water from the source of supply. Therefore, assuming that a federal or other governmental agency finances and administers any interbasin water transfer project, it will be the responsibility of that agency to apply for and obtain a water use permit from the Department of Natural Resources and Conservation before commencement of the project's construction. Use of transferred water within the Milk River Basin would then probably be accomplished on a contract basis between the sponsoring agency and individual users.

PART VI
CONCLUSIONS AND RECOMMENDATIONS

Conclusions

There has been and will continue to be a water shortage in the Milk River Basin, barring a climatic change that could increase the precipitation. Thus, the basin needs additional water by import, or by more impoundments. Also, possessors of current water rights or use permits need to have those rights adjudicated in the near future.

Recommendations

1. Route 1: Marias-Milk should not be considered further because of an adverse benefit:cost ratio (see table 1, page 4 and appendix B).

2. Route 4: Duck Creek-Vandalia should not be considered further because of a very low benefit:cost ratio and because of adverse environmental impacts (see table 1, page 4 and appendix B). Lower expected crop yields can decrease the benefit:cost ratio below the 1:1 level.

3. A feasibility level analysis should be conducted on alternative Routes 2 and 3 to derive a more specific benefit:cost evaluation. Priority should be directed to study activities on Route 2 to determine, as soon as possible, if the route is economically viable. If not, it should be deleted as a potential route selection and then Route 3 should be analyzed in detail to establish specific feasibility. Study activities of both Routes 2 and 3 should include a thorough analysis of Environmental Quality benefits and costs. Lower expected crop yields can decrease the benefit:cost ratio below the 1:1 level.

4. Further study should be conducted regarding development of additional in-basin storage sites which will not supply additional water but which will make water available during some critical periods.

5. This Department, in cooperation with other state and federal agencies, should continue water supply investigations in the Milk River Basin, taking into consideration Canadian use. The future denial of new water use permits from the Milk River proper should be considered, based upon this and future studies.

APPENDICES

APPENDIX A

FISH AND WILDLIFE IMPACTS

1st Draft

STATE OF MONTANA

DEPARTMENT OF FISH AND GAME

Planning Division
Research Park Building
Box 5 - MSU Campus
Bozeman, MT 59715

November 24, 1976

Attention: Walt Siler

Jack Acord
Department of Natural Resources
and Conservation
32 South Ewing
Helena, MT 59601

Re: Fish and wildlife evaluation (preliminary) of four alternative routes of providing supplemental water to the Milk River Valley

Discussions on the above subject were held at Malta and Saco with Jack Foster, Refuge Manager, Bowdoin Waterfowl Refuge, U.S. Fish and Wildlife Service and Frank Gjersing, Biologist, Montana Department of Fish and Game. Meetings held last spring and subsequent talks with several ranchers and townspeople on the need for water along the Milk River indicate there will be a definite shortage if any further diversions take place and/or Canada holds back their allotment.

Route 1 Marias-Milk

The first consideration of this proposal must be a continuation of stream flow below Marias Dam that will maintain the present fishery. This has developed into a significant fishery and must be maintained.

The amount of water being requested for the Milk River from the Marias River is at present not significant in relation to the storage capacity -- under full Marias irrigation development it may become a problem.

Development of Chain of Lakes and Lonesome Lake for wildlife management would be a tremendous addition to the numbers waterfowl and related water-oriented species of wildlife now found in limited numbers in this highly developed dry-land farming area.

The amount of water necessary to manage both of these areas with maximum efficiency has not been fully determined.

In addition, there is a potential for wildlife development projects along Big Sandy Creek -- providing saline seep does not become an overriding factor.

Benefits to wildlife at Bowdoin Refuge would accrue under this plan with additional water (see plan #3).

Additional water is needed to optimize wildlife and fish resources at Dodson Dam, Nelson Reservoir and Rookery Recreation Area. Dodson Dam needs additional water (est. 2,000 acre feet) in March to make use of goose nesting islands not now used because of low water. It is also believed the additional water would improve the fishery. Nelson Reservoir is drawn down in July, August and early September; additional water would benefit the fishery -- amount undetermined. Rookery Recreation Area needs additional water to irrigate and improve 200 to 300 acres of pheasant and deer habitat.

The supplementary water service plan would not provide any downstream wildlife benefits, and would, notably, be a minus factor at Tiber.

At present we recommend Alternative No. 1 Full Service Plan as the plan with the greatest potential wildlife benefits, and suggest it be pursued to the feasibility level.

Route 2 Virgelle-Havre

There are a few areas with potential for fish and wildlife that could be developed along Big Sandy Creek but nothing comparable to Route No. 1. Saline seep is a potential problem everywhere along the flood plain. A fishery may develop along lower Big Sandy Creek if water quality can be maintained. Downstream benefits below Fresno Reservoir listed in Plans 1 and/or 3 would also be available here.

Route 3 Telegraph Creek-Beaver Creek

U. L. Bend Wildlife Refuge would be significantly improved with a reliable water supply but it is believed additional pumping (60 ft. lift) would be required to bring it from the proposed route to the refuge and would probably be too costly for benefits received.

It was the consensus of opinion that additional agricultural development that would occur along Telegraph Creek and Beaver Creek under Plan 3 would result in a net loss of wildlife habitat. Flood irrigation now limits the amount of agricultural development and provides wildlife habitat values that would be lost if additional water led to increased agricultural development.

Bowdoin Refuge is presently receiving approximately 3,500 acre feet of water annually that is used filling, maintenance and occasionally flushing. An additional 12,000 acre feet (estimated) is needed to accelerate the flushing action during high water periods in the Milk River that would not deteriorate water quality.

This proposed route does not cross the newly designated wilderness area according to Foster.

Route 4 Duck Creek-Vandalia

Only wildlife benefits from additional water used upstream would accrue from this plan -- no direct benefits are foreseen and environmental problems caused by a ditch 100 feet deep would be astronomical.

Additional irrigation development in areas now used for dry land farming would probably be a net benefit to wildlife. Additional irrigation at the expense of clearing bottom lands or plowing rangeland would result in a loss of wildlife habitat.

Where new irrigation development proposals encroach on critical wildlife habitat such as the very limited antelope winter range north of Malta, there is a possibility of eliminating an entire antelope herd. Antelope migrate to this winter range from a large area north of the Milk River and represent a major portion of the Hi-line herd. This loss must be weighed against any benefits elsewhere.

Sincerely yours,

Don L. Brown
Administrator

DLB:pcw

cc: Dick Johnson
Jack Foster

APPENDIX B

SUPPLEMENTAL WATER SUPPLY
ECONOMIC AND REPAYMENT ANALYSES
MILK RIVER BASIN

MONTANA

Prepared by Division of Planning
Bureau of Reclamation
U.S. Department of Interior

Upper Missouri Region
P. O. Box 2553, Billings, Montana 59103

August 1976

(Revised November 1976)

Reviewed and Revised by
Montana Department of Natural Resources and Conservation

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INTRODUCTION

This report presents the economic analysis and the repayment analysis for each of four possible routes for diversion of water to the Milk River.

Each alternative includes an analysis for providing supplemental water to the Milk River Valley to meet existing shortages as well as developing new irrigable lands en route, and an analysis for providing only supplemental water or a combination of supplemental and full water supply. The four alternatives are identified as follows:

Alternative No. 1	Marias-Milk
Alternative No. 2	Virgelle-Havre
Alternative No. 3	Telegraph Creek-Beaver Creek
Alternative No. 4	Duck Creek-Vandalia

All economic analyses and repayment analyses are in accordance with accepted Bureau standards and/or instructions.

REPORT ORGANIZATION

The presentation of each alternative plan is organized under the following sections:

A. Plan of Development
B. Proposed Plan
C. Irrigation Benefits
D. Cost Estimates
    1. Construction Costs
    2. Interest During Construction
    3. Annual Equivalent Values
    4. Operation, Maintenance, and Replacement Costs
E. Plan Evaluation
    1. National Economic Development Account
    2. Regional Development Account
    3. Social Well-Being Account
F. Cost Allocation (Full Service Plan Only)
G. Repayment Analysis

In order to expedite the presentation, a brief explanation follows for those sections on which there may be questions as to content.

1. Irrigation Benefits (or Beneficial Effects)

Irrigation benefits measure the increase in annual income to farmers due to the supplemental and full water supply provided under the irrigation project. Net benefits are derived for farms using both a "with irrigation" and a "without irrigation" analysis.

The "without" situation is the economic conditions that would exist in 1985 without diversion of water to the Milk River. Irrigated crop yields are those average crop yields that are presently attained in the Milk River Irrigation Project. Dryland crop yields are the average for the four-county area of Blaine, Hill, Phillips, and Valley. Prices paid and received by farmers are the current normalized prices as developed by the Water Resources Council as of October 1975.

The "with" situation is the economic condition that would exist in 1985 based on a full water supply. Irrigated crop yields are those that are projected to be attained with a full water supply by 1985. Prices paid and received by farmers are the same prices as used in the "without" situation.

The complete farm budget analysis is found in appendix C.

2. Cost Estimates (or Adverse Effects)

Total costs of each project include all costs involved in construction of the facility, including interest accumulated on construction funds during the construction period. These costs are evaluated at the current interest rate of 6 1/8 percent. Annual equivalent values are determined for the total investment costs, so that they can be compared to annual benefits. These equivalent values are determined for a 100-year period of analysis, using an interest rate of 6 1/8 percent.

3. Plan Evaluation

Evaluation of each plan alternative is accomplished by using the guidelines established by the Bureau of Reclamation for implementing the principles and standards for "Multi-objective Planning (MOP) of Water Resources." Under the MOP procedures, provision is made for evaluating costs and benefits under three separate accounts: the National Economic Development Account (NED), the Regional Development Account (RD), and the Social Well-Being Account (SWB).

National Economic Development Account

The NED Account is used to measure the benefits and costs that accrue to the nation. Benefits are measured as the direct returns to the water user. Adverse effects or costs are the investment costs required to implement the plan. Investment costs include the installation cost; interest during construction, operation and maintenance; replacement costs; and any other cost associated with the project.

Regional Development Account

The RD Account provides a more comprehensive summary of monetary benefits to the region. In addition to the direct user benefits included in the NED Account, the RD Account also includes an estimate of benefits induced by provision of inputs to the increased agricultural output, as well as the benefits stemming from the handling and processing of the increased output.

Additionally, the RD Account provides an estimate of employment income to the region created by the construction of the project.

The adverse effects are equal to the adverse effects in the NED Account.

Social Well-Being Account

The SWB Account is used to measure the nonmonetary impacts of the plans. These impacts can be a social gain or loss to the region due to the plan. They are not easily assigned an economic value but can be identified, described, or physically counted in this account.

ALTERNATIVE NO. 1: MARIAS-MILK

Full Service Plan

Plan of Development

The principal purpose of the Marias-Milk Route would be irrigation development of about 72,700 irrigable acres of new land and the provision of supplemental water service to the Milk River Valley, using Marias River water stored in the existing Lake Elwell (Tiber Reservoir). By means of an 80.2-mile canal, water from Lake Elwell would be conveyed to Fresno Reservoir on the Milk River, where, after regulation, it would be released down the river to irrigate 19,900 acres of new land and to supply supplemental water for existing irrigation developments. En route to Fresno, a distribution system would be constructed to provide gravity irrigation service to about 37,800 acres of new land in the Central Marias Area. A branch canal, 64.2 miles long, would convey irrigation water across Big Sandy Creek for delivery to 15,000 irrigable acres in the Big Sandy Area. The 19,900 acres of new land in the Milk River Valley would be served by privately constructed and operated pumping and water distribution facilities.

Proposed Plan

Project works associated with the Marias-Milk Route are discussed in downstream order as follows:

To release water from Lake Elwell, a 4,737-foot concrete-lined horseshoe tunnel, 15 feet in diameter, would be required. The tunnel would extend from the existing outlet tunnel incorporated in the original construction of Tiber Dam and would be located around the left abutment of the dam.

At the outlet portal of the tunnel, water would enter the Marias-Milk Canal. The canal would extend 80.2 miles. It would have an initial capacity of 1,500 cfs, would change from 1,190 cfs to 540 cfs at the bifurcation structure and would have a terminal capacity of 400 cfs into Fresno Reservoir. Major structures on the canal would consist of seven siphons with lengths ranging from 228 to 7,760 feet; a bifurcation structure for releasing water into the Big Sandy Canal; a fish filter or screen; two Parshall flumes and one rating section for measurement of canal flows; numerous bridges for crossings; 13 drops and a terminal drop into Fresno Reservoir; and 40 lateral and farm turnouts. Structures also would include drainage inlets and cross drainage culverts. One lateral would be constructed to divert water into Chain-of-Lakes Coulee for fish and wildlife use. The upper end of all major structures would be equipped with appropriate protective and escape devices, such as safety nets and slope ladders, to protect humans, livestock and wild animals and to assist them in escaping from the canal.

Laterals required to serve irrigable land in the Central Marias Area would range in capacity from 93 to 5 cfs. For purposes of estimating costs, concrete lining was assumed for all laterals with capacities of 50 cfs or less. Irrigable land in the Central Marias Area would be served as shown in table 1-B.

TABLE 1-B

SERVICE TO THE CENTRAL MARIAS AREA

Acreage served directly from Marias-Milk Canal	1,083
Acreage served directly from Big Sandy Canal	607
Acreage served from laterals and sublaterals	36,110[a]
Total Acreage Central Marias Area	37,800

[a]Includes about 500 acres that are situated immediately above the gravity system and would be served by pumping from a lateral.

A system of project drains would be required in the Central Marias Area.

Big Sandy Canal would receive its water from the Marias-Milk Canal, through the bifurcation structure, for irrigation of 15,000 acres of irrigable land in the Big Sandy Area, as well as the 607 acres in the Central Marias Area. This canal would extend for 64.2 miles. It would have an initial capacity of 515 cfs and a capacity of 15 cfs at the terminal wasteway. Major structures on the canal would consist of three siphons with lengths of 354 feet, 17,410 feet, and 540 feet; a Parshall flume; three wasteways; one 1,330-foot concrete chute, with three 8-foot by 7-foot radial gates; numerous county road bridges; plus many turnouts, drops, and checks. Because of a high ground water table, concrete lining would be required when the canal capacity would be reduced to 50 cfs or less. In the Big Sandy Canal there would be about 6.8 miles of concrete lining and 22.6 miles of earth lining.

For cost estimating purposes, all laterals in the Big Sandy Area were assumed to require concrete lining, as none exceed 50 cfs in capacity. These laterals would serve 14,211 of the 15,000 irrigable acres in Big Sandy Area. The remaining 789 acres would be served directly from Big Sandy Canal. A lateral turnout would be constructed to divert water into Twelve Mile Coulee for fish and wildlife use at Lonesome Lake. In addition, a turnout would be provided in the Big Sandy Canal to provide water service for the town of Big Sandy and the Big Sandy Cemetery.

As in the Central Marias Area, a complex system of project drains will also be required in the Big Sandy Area.

No additional facilities would be required at Fresno Dam and Reservoir. During the peak irrigation season, additional releases of 400 cfs would be required in the Milk River from Fresno Reservoir to meet the supplemental water requirements and needs of additional new lands included in this plan.

New lands of the Milk River Area included in the Marias-Milk Unit, totaling 19,900 irrigable acres, would be served by private pumping. Individual water users would construct their own pumping and distribution facilities, but project drains on these lands would be constructed during the development period.

Permanent operation and maintenance facilities required to operate the Unit efficiently would involve construction of an office, shop, and garage in the town of Big Sandy. A shop-storage building and equipment yard would be located in the Central Marias Area.

Irrigation Benefits

The Marias-Milk Route provides for full irrigation service to 72,700 acres, and supplemental water to 108,140 acres in the Milk River Valley. Annual benefits per acre as determined in the farm budget analysis, amount to $45 per acre for the supplemental irrigation service and $70 per acre for the full irrigation service. Table 2-B summarizes computations of the benefits. Note that benefits derived from full service irrigation to new lands are discounted by a development factor of .891 to compensate for time necessary to adjust agricultural techniques to fully utilize the additional productive potential.

TABLE 2-B

BENEFITS FOR THE MARIAS-MILK ROUTE

FULL SERVICE:		
72,700 acres x $70/acre x .891 =		$4,534,299
SUPPLEMENTAL SERVICE:		
108,140 acres x $45/acre =		4,866,300
TOTAL ANNUAL BENEFITS		$9,400,599
	Rounded	$9,401,000

Cost Estimates

Cost estimates for all facilities of the Marias-Milk Full Service Plan were taken from a 1972 Feasibility Report on the Marias-Milk Unit and indexed to January 1976 price levels. The total project cost of the plan is estimated at $158,580,000, as summarized in table 3-B. Table 4-B shows interest during construction, and table 5-B shows the annual equivalent value.

TABLE 3-B

COST ESTIMATES

Marias-Milk Tunnel and Canal	$ 71,747,000
Big Sandy Canal	22,002,000
Central Marias Area Irrigation Facilities	41,022,000
Big Sandy Area Irrigation Facilities	18,539,000
Milk River Valley Irrigation Facilities	3,002,000
Permanent Operating Facilities	789,000
Fish and Wildlife Facilities	941,000
TOTAL CONSTRUCTION COST	$158,042,000
Settlers Assistance Cost	538,000
TOTAL INSTALLATION COST	$158,580,000

TABLE 4-B

INTEREST DURING CONSTRUCTION

Construction Year	Installation Cost	Yrs. Int.	
1	$ 8,000,000	5.5	$ 44,000,000
2	16,000,000	4.5	72,000,000
3	20,000,000	3.5	70,000,000
4	45,000,000	2.5	112,500,000
5	45,000,000	1.5	67,500,000
6	24,580,000	.5	12,290,000
	$158,580,000		$378,290,000
			x .06125
TOTAL INTEREST DURING CONSTRUCTION			$ 23,170,263
		Rounded	$ 23,170,000

TABLE 5-B

ANNUAL EQUIVALENT VALUE

Installation Cost	$158,580,000
Interest During Construction	23,170,000
TOTAL PROJECT COST	$181,750,000
Amortization Factor	x .06141
Annual Equivalent Value	$ 11,161,268
Rounded	$ 11,161,000

Operation, Maintenance, and Replacement Costs

The annual OM&R costs for the Marias-Milk Full Service Plan are $309,000.

Plan Evaluation

The comparison of benefits and costs is developed for the National Economic Development Account (NED), the Regional Development Account (RD), and the Social Well-Being Account (SWB), utilizing MOP procedures. The NED and RD Accounts are summarized in table 6-B.

TABLE 6-B

MARIAS-MILK FULL SERVICE PLAN

NED ACCOUNT		
BENEFICIAL EFFECTS		
Irrigation		$ 9,400,000
ADVERSE EFFECTS		
Investment	$11,161,000	
OM&R	309,000	
TOTAL ADVERSE EFFECTS		- 11,470,000
NET BENEFICIAL EFFECTS		-$ 2,070,000
RD ACCOUNT		
BENEFICIAL EFFECTS		
User Benefits		
Irrigation		$ 9,400,000
Regional Benefits		
Employment	$ 1,118,000	
Induced & stemming	10,528,000	
Total Regional Benefits		11,646,000
TOTAL BENEFICIAL EFFECTS		$21,046,000
ADVERSE EFFECTS		
Investment	$11,161,000	
OM&R	309,000	
TOTAL ADVERSE EFFECTS		- 11,470,000
NET BENEFICIAL EFFECTS		$ 9,576,000

The following analyses were used in developing the SWB Account:

1. Construction employment would range from about 100 to 600 workers during the 6-year construction period.

2. Assuming that 40 percent of the construction labor force is locally supplied, the total population influx during the construction period would vary from about 138 to 828 people. Thus, there would be an increased demand for housing, supplied principally by mobile homes. The influx would also require social and cultural adjustments by local citizens.

3. Increased annual income to the area, including $9,400,000 in direct income to farmers from irrigation, would provide an increased and stabilized economic base and enhance social well-being.

Cost Allocation

Investment costs were allocated to determine repayment of the project investment costs. The investment cost required to provide water for the supplemental acres and the new full irrigated acres would be different. Also, investment costs for fish and wildlife facilities are included in this plan. The irrigators are not required to pay the investment cost for these facilities.

The procedure used to allocate costs was to determine the investment cost to provide water to the supplemental acres. The investment cost plus the investment cost for the fish and wildlife facilities was subtracted from the total investment costs for the Full Service Plan. The difference after subtracting these two costs is the investment cost allocated to the new full irrigated acres.

Derivation of the investment costs for the supplemental acres and fish and wildlife is shown in table 7-B.

TABLE 7-B

MARIAS-MILK INVESTMENT COSTS

Supplemental Acres		Fish and Wildlife Facilities
Construction Costs	$29,043,000	$ 941,000
Interest During Construction	2,920,000	141,000
Investment Cost	$31,963,000	$1,082,000

Investment Costs		
Full Service Plan		$181,750,000
Supplemental Acres	$31,963,000	
Fish and Wildlife Facilities	1,082,000	
		- 33,045,000
New Full Irrigated Acres		$148,705,000

Operation, maintenance, and replacement costs (table 8-B) were allocated using the same procedure.

TABLE 8-B

OM&R COSTS

Full Service Plan		$309,000
Supplemental Acres	$70,000	
Fish and Wildlife Facilities	1,000	
		- 71,000
New Full Irrigated Acres		$238,000

Repayment Analysis

The irrigators would be required to repay the investment costs and the operation, maintenance, and replacement (OM&R) costs.

Total investment costs for this plan are $181,750,000. The OM&R costs are $309,000. The supplemental irrigation service is $70,000 or $0.65 per acre and the new full irrigation service is $238,000 or $3.27 per acre.

This alternative does not meet National Economic Development (NED) criteria. Therefore, it would have to be developed by the State or irrigation district without Federal assistance. Irrigators would have the option of repaying the costs under one of the following repayment plans.

Repayment Plan No. 1

This plan would require the investment to be repaid with interest. The irrigation district would borrow the money from a lending institution or issue bonds to be repaid in 50 years with interest. An interest rate of 8 percent was used to derive an annual payment of $12,155,572 or $167.20 per acre for the new full irrigation service. The supplemental irrigation service would have an annual payment of $2,730,000 or $24.16 per acre. The total annual per acre payment including OM&R would be $168.85 for the new full irrigation service and $25.90 for the supplemental irrigation service.

Repayment Plan No. 2

Using this plan the irrigation district would borrow the investment from the Federal government. Repayment would be for 50 years without interest. The annual payment would be $2,945,000 or $40.51 per acre for the new full irrigation service. The supplemental irrigation service annual payment would be $668,000 or $6.18 per acre. The total annual per acre payment including OM&R would be $43.78 for the new full irrigation service and $6.83 for the supplemental irrigation service.

Supplemental Water Service Plan

Plan of Development

The principal purpose of this plan is to provide supplemental water service to the Milk River Valley.

Proposed Plan

Project works associated with diversion of supplemental water from Lake Elwell (Tiber Reservoir) to Fresno Reservoir are discussed in downstream order as follows:

The diversion canal would follow the same route as the Marias-Milk Canal in the Full Service Plan, but its size would be reduced.

To release water from Lake Elwell, a 4,737-foot concrete-lined horseshoe tunnel, six feet in diameter, would be required.

At the outlet portal of the tunnel, water would enter the diversion canal. The canal would extend 80.2 miles. It would have an initial capacity of 230 cfs with a terminal capacity of 170 cfs into Fresno Reservoir. Major structures on the canal would consist of seven siphons, with lengths ranging from 228 to 7,760 feet; a fish filter or screen; 13 drops and a terminal drop into Fresno Reservoir; numerous bridges for crossings; and a drainage inlet and cross drainage culverts. The upper end of all major structures would be equipped with appropriate protective and escape devices, as mentioned in the Full Service Plan.

No additional facilities would be required at Fresno Dam and Reservoir. The existing operation and maintenance facilities at Tiber Dam and Reservoir could be used.

Irrigation Benefits

The Marias-Milk Supplemental Water Service Plan provides for supplemental water service to 108,140 acres. Benefits per acre, as determined in the farm budget analysis (appendix C), amount to $45 for the supplemental service. The annual benefits would be $4,866,000 (rounded from table 2-B).

Cost Estimates

Cost estimates for all facilities of the Marias-Milk Supplemental Water Service Plan are of reconnaissance grade at January 1976 price levels. The total project cost of the plan for Marias-Milk diversion tunnel and canal is estimated at $29,043,000. Table 9-B shows interest during construction, and table 10-B shows annual equivalent value.

TABLE 9-B

INTEREST DURING CONSTRUCTION

Construction Year	Installation Cost	Yrs. Int.	
1	$ 500,000	3.5	$ 1,750,000
2	7,842,000	2.5	19,605,000
3	15,974,000	1.5	23,961,000
4	4,727,000	.5	2,364,000
	$29,043,000		$47,680,000
			x .06125
TOTAL INTEREST DURING CONSTRUCTION			$ 2,920,400
		Rounded	$ 2,920,000

TABLE 10-B

ANNUAL EQUIVALENT VALUE

Installation Cost		$29,043,000
Interest During Construction		2,920,000
TOTAL PROJECT COST		$31,963,000
Amortization Factor		x .06141
Annual Equivalent Value		$ 1,962,847
	Rounded	$ 1,963,000

Operation, Maintenance, and Replacement Costs

Annual OM&R costs for the Marias-Milk Supplemental Water Service Plan are $70,000.

Plan Evaluation

Table 11-B summarizes the comparison of benefits and costs, determined by MOP procedures, for the NED and RD Accounts.

TABLE 11-B

MARIAS-MILK SUPPLEMENTAL WATER SERVICE PLAN

NED ACCOUNT		
BENEFICIAL EFFECTS		
Irrigation		$4,866,000
ADVERSE EFFECTS		
Investment	$1,963,000	
OM&R	70,000	
TOTAL ADVERSE EFFECTS		- 2,033,000
NET BENEFICIAL EFFECTS		$2,833,000
RD ACCOUNT		
BENEFICIAL EFFECTS		
User Benefits		
Irrigation		$ 4,866,000
Regional Benefits		
Employment	$ 196,000	
Induced & stemming	5,450,000	
Total Regional Benefits		5,646,000
TOTAL BENEFICIAL EFFECTS		$10,512,000
ADVERSE EFFECTS		
Investment	$1,963,000	
OM&R	70,000	
TOTAL ADVERSE EFFECTS		- 2,033,000
NET BENEFICIAL EFFECTS		$ 8,479,000

The following analyses were used in developing the SWB Account:

1. Construction employment would range from about 60 to 210 workers during the three-year construction period.

2. Assuming that 40 percent of the construction labor force is locally supplied, the total population influx during the construction period would vary from about 80 to 280 people. Thus, there would be an increased short-term demand for housing, supplied principally by mobile homes. The influx would also require social and cultural adjustments by local citizens.

3. Increased annual income to the area, including $4,866,000 in direct income to farmers from irrigation would provide an increased and stabilized economic base and enhance social well-being.

Repayment Analysis

The irrigators would be required to repay the investment costs and the operation, maintenance, and replacement (OM&R) costs. Investment costs for this plan are $31,963,000. The OM&R costs are $70,000 or $0.65 per acre.

Irrigators would have the option of repaying the costs under one of the following repayment plans.

Repayment Plan No. 1

This plan would require the investment to be repaid with interest. The irrigation district would borrow the money from a lending institution or issue bonds to be repaid in 50 years with interest. An interest rate of 8 percent was used to derive an annual payment of $2,613,000 or $24.16 per acre. The total annual payment per acre including OM&R would be $24.81.

Repayment Plan No. 2

Using this plan the irrigation district would borrow the investment from the Federal government. Repayment would be for 50 years without interest. The annual payment would be $639,000 or $5.91 per acre. The total annual payment per acre including OM&R would be $6.56.

Repayment Plan No. 3

The irrigation district would recommend that the Milk River Irrigation project become part of the Pick-Sloan Missouri River Basin Power Plan (P-SMRBP). Repayment arrangements in the P-SMRBP Plan are that the irrigators repay to their ability, and excess power revenues would repay the balance of the investment cost. Present repayment criteria suggests that irrigators repay at least 25 percent of the investment. Using this procedure the annual payment would be $160,000 or $1.48 per acre. The total annual payment per acre including OM&R would be $2.13.

ALTERNATIVE NO. 2: VIRGELLE-HAVRE

Full Service Plan

Plan of Development

The principal purpose of this plan is to provide supplemental water service to the Milk River Valley and serve irrigation development of 24,000 irrigable acres of new land en route by pumping from the Missouri River. With a pumping plant located near the small community of Virgelle, water from the Missouri River would be conveyed by a 42-mile canal in the Big Sandy Creek drainage to a regulation reservoir. The reservoir would be located approximately one mile east from the confluence of Big Sandy Creek and Milk River. After regulation, the water would be released down the river to supply supplemental water to existing irrigation developments. En route to the Milk River, a distribution system to be constructed would provide gravity irrigation service to 24,000 acres of new land. Further relifting of a portion of the water from the conveyance canal would be required to serve 9,000 of the 24,000 acres.

Proposed Plan

Project works associated with this plan are discussed in downstream order as follows:

To divert water from the Missouri River, a 415 cfs pumping plant lifting water 200 feet to a conveyance canal would be required. The canal would extend 42 miles. It would have an initial capacity of 415 cfs and a terminal capacity of 170 cfs when entering the regulation reservoir. The regulation reservoir would be constructed of zoned earthfill, approximately 70 feet in height, and have a storage capacity of 16,000 acre-feet. Major structures on the canal would consist of two siphons, each ¼ to ½ mile long; a bifurcation structure for servicing 6,000 acres of irrigable land; numerous bridges for crossing; five drops; and lateral and farm turnouts. Structures also would include drainage inlets and cross drainage structures. The upper end of all major structures would be equipped with appropriate protective and escape devices, as mentioned for Alternative 1.

Laterals were estimated on a per acre basis, established from previous investigations and estimates made in the 1972 Feasibility Report on the Marias-Milk Unit. Concrete lining was assumed for all laterals with capacities of 50 cfs or less.

Approximately 9,000 irrigable acres of land to be served en route lie in the Virgelle Area, requiring further pumping for as much as 150 feet to 3,000 of those acres. The remaining 15,000 acres lie in the Big Sandy Area and would require further pumping of approximately 50 feet to 6,000 acres of that land.

An extensive system of project drains would be required for this land. Drains were estimated on a per acre basis.

The regulation reservoir would have an outlet structure for releasing the supplemental water into the Milk River. During the irrigation season the additional release to the river would be 170 cfs.

Permanent operation and maintenance facilities required to operate the unit efficiently would include an office, shop, and garage to be located in the town of Big Sandy.

Irrigation Benefits

The Virgelle-Havre Full Service Plan provides for full irrigation service to 24,000 acres, and supplemental water to 108,140 acres in the Milk River Valley. Benefits per acre, as determined in the farm budget analysis, amount to $45 for supplemental service and $70 for full irrigation service. Table 12-B summarizes computations of the benefits. Note that benefits derived from full service irrigation to new lands are discounted by a development factor of .891 to compensate for time necessary to adjust agricultural techniques to fully utilize the additional productive potential.

TABLE 12-B

BENEFITS FOR THE VIRGELLE-HAVRE ROUTE

FULL SERVICE:		
24,000 acres x $70/acre x .891 =		$1,496,880
SUPPLEMENTAL SERVICE:		
108,140 acres x $45/acre =		4,866,300
TOTAL ANNUAL BENEFITS		$6,363,180
	Rounded	$6,363,000

Cost Estimates

Cost estimates for all facilities of the Virgelle-Havre Full Service Plan are of reconnaissance grade at January 1976 price levels. Total project cost of the plan is estimated at $64,430,000, as summarized in table 13-B. Table 14-B shows interest during construction, and Table 15-B shows the annual equivalent value.

TABLE 13-B

COST ESTIMATES

Virgelle Pumping Plant	$ 7,600,000
Virgelle-Havre Canal	12,300,000
Regulation Demand Reservoir	6,700,000
Virgelle Area Irrigation Facilities	15,770,000
Big Sandy Area Irrigation Facilities	21,560,000
Permanent Operating Facilities	325,000
TOTAL CONSTRUCTION COST	$ 64,255,000
Settlers Assistance Cost	175,000
TOTAL INSTALLATION COST	$ 64,430,000

TABLE 14-B

INTEREST DURING CONSTRUCTION

COSTS WITHOUT PUMPING PLANT

Construction Year	Installation Cost	Yrs. Int.	
1	$ 900,000	4.5	$ 4,050,000
2	13,000,000	3.5	45,500,000
3	17,000,000	2.5	42,500,000
4	15,000,000	1.5	22,500,000
5	10,930,000	.5	5,465,000
	$56,830,000		$120,015,000
			x .06125
TOTAL INTEREST DURING CONSTRUCTION			$ 7,350,900
		Rounded	$ 7,351,000

PUMPING PLANT

Construction Year	Installation Cost	Yrs. Int.	
1	$ 150,000	2.5	$ 375,000
2	2,900,000	1.5	4,350,000
3	4,550,000	.5	2,275,000
	$7,600,000		$ 7,000,000
			x .06125
TOTAL INTEREST DURING CONSTRUCTION			$ 428,750
		Rounded	$ 429,000
			$ 7,351,000
			429,000
TOTAL INTEREST DURING CONSTRUCTION			$ 7,780,000

TABLE 15-B

ANNUAL EQUIVALENT VALUE

Installation Cost	$64,430,000
Interest During Construction	7,780,000
TOTAL PROJECT COST	$72,210,000
Amortization Factor	x .06141
Annual Equivalent Value	$ 4,434,416
Rounded	$ 4,434,000

Operation, Maintenance, and Replacement Costs

The OM&R costs for the Virgelle-Havre Full Service Plan are $306,100. Power costs would be $112,500 based on 2.5 mill power from the Pick-Sloan Missouri River Basin Power Plan. This power could be used if excess power is available. Presently, all power produced from P-SMRBPP is being used.

Plan Evaluation

The comparison of benefits and costs is developed for the National Economic Development Account (NED), the Regional Development Account (RD), and the Social Well-Being Account (SWB), utilizing MOP procedures. The NED and RD Accounts are summarized in Table 16-B.

TABLE 16-B

VIRGELLE-HAVRE FULL SERVICE PLAN

NED ACCOUNT

BENEFICIAL EFFECTS		
Irrigation		$ 6,363,000
ADVERSE EFFECTS		
Investment	$ 4,434,000	
OM&R	306,000	
TOTAL ADVERSE EFFECTS		-4,740,000
NET BENEFICIAL EFFECTS		$ 1,623,000

	RD ACCOUNT	
BENEFICIAL EFFECTS		
User Benefits		
Irrigation		$ 6,363,000
Regional Benefits		
Employment	$ 319,000	
Induced & stemming	7,127,000	
Total Regional Benefits		7,446,000
TOTAL BENEFICIAL EFFECTS		$13,809,000
ADVERSE EFFECTS		
Investment	$4,434,000	
OM&R	306,000	
TOTAL ADVERSE EFFECTS		-4,740,000
NET BENEFICIAL EFFECTS		$ 9,069,000

The following analyses were used in developing the SWB Account:

1. Annual construction employment would range from about 150 to 300 workers during the four-principal-year construction period.

2. Assuming that 40 percent of the construction labor is locally supplied, the total population influx during the construction period would vary from about 200 to 400 people. Thus, there would be short-term increased demand for housing, supplied principally by mobile homes. Also, the influx would require social and cultural adjustments by local citizens.

3. Increased annual income to the area, including $6,363,000 in direct income to farmers from irrigating, would provide an increased and stabilized economic base and enhance social well-being.

Cost Allocation

Investment costs were allocated to determine repayment of the project investment costs. The investment cost required to provide water for the supplemental acres and the new full irrigated acres would be different.

The procedure used to allocate costs was to determine the investment cost to provide a water supply to the supplemental acres. This investment cost was subtracted from the total investment costs for the Full Service Plan. The difference after subtracting this cost is the investment cost allocated to the new full irrigated acres.

Derivation of the investment costs for the supplemental acres is shown in Table 17-B.

TABLE 17-B

VIRGELLE-HAVRE INVESTMENT COSTS

	Supplemental Acres
Construction Cost	$22,140,000
Interest During Construction	2,657,000
Investment Cost	$24,797,000
	Investment Cost
Full Service Plan	$72,210,000
Supplemental Acres	-24,797,000
New Full Irrigated Acres	$47,413,000

Operation, maintenance, and replacement costs (table 18-B) were allocated using the same procedure.

TABLE 18-B

OM&R COSTS

Full Service Plan	$306,100
Supplemental Acres	-111,000
New Full Irrigated Acres	$195,100

Repayment Analysis

The irrigators would be required to repay the investment costs and the operation, maintenance, and replacement (OM&R) costs.

Total investment costs for this plan are $72,210,000. The OM&R costs are $306,100. OM&R costs for the supplemental water supply are $111,000 or $1.03 per acre and the new full water supply are $195,100 or $8.13 per acre.

Irrigators would have the option of repaying the costs under one of the following repayment plans.

Repayment Plan No. 1

This plan would require the investment to be repaid with interest. The irrigation district would borrow the money from a lending institution or issue bonds to be repaid in 50 years with interest. An interest rate of 8 percent was

used to derive an annual payment of $2,027,000 or $18.74 per acre for the supplemental irrigation service and an annual payment of $3,876,000 or $161.50 per acre for the new full irrigation service. The total annual per acre payment including OM&R would be $19.77 for the supplemental irrigation and $169.63 for the full irrigation service.

Repayment Plan No. 2

Using this plan the irrigation district would borrow the investment from the Federal government. Repayment would be for 50 years without interest. The annual payment would be $496,000 or $4.59 per acre for the supplemental irrigation service and an annual payment of $948,000 or $39.50 per acre for the new full irrigation service. The total annual per acre payment including OM&R would be $5.62 for the supplemental irrigation service and $47.63 for the full irrigation service.

Repayment Plan No. 3

The irrigation district would recommend that the Milk River Irrigation Project become part of the Pick-Sloan Missouri River Basin Power Plan. Repayment arrangements in the P-SMRBP Plan are that the irrigators repay to their ability, and excess power revenues would repay the balance of the investment cost. Present repayment criteria suggests that irrigators repay at least 25 percent of the investment. Using this procedure the annual payment would be $237,000 or $9.88 per acre for the new full irrigation service and an annual payment of $124,000 or $1.15 per acre for the supplemental irrigation service. The total annual payment per acre including OM&R would be $2.18 for the supplemental irrigation service and $18.01 for the new full irrigation service.

Supplemental Water Service Plan

Plan of Development

The single purpose of this plan is to provide supplemental water service to the Milk River Valley by pumping from the Missouri River. A pumping plant located near Virgelle would lift water from the Missouri River to be conveyed by a 42-mile canal to a regulation reservoir near the Milk River. Water would then be released down the river to supply supplemental water for existing irrigation developments.

Proposed Plan

Project works associated with this plan are discussed in downstream order as follows:

To divert water from the Missouri River, a 200 cfs pumping plant lifting the water 200 feet to a conveyance canal would be required. The canal would extend

for 42 miles. It would have an initial capacity of 200 cfs and a terminal capacity of 170 cfs when entering the regulation reservoir. The regulation reservoir would be constructed of zoned earthfill, approximately 70 feet in height with a storage capacity of 16,000 acre-feet. Major structures on the canal would consist of two siphons, ¼ to ½ mile long; numerous bridges for crossing; and five drops. There would also be several drainage inlets and cross drainage structures. The upper end of all major structures would be equipped with appropriate protective and escape devices, as mentioned for Alternative 1.

The regulation reservoir would have an outlet structure for releasing the supplemental water into the Milk River. During the irrigation season the additional release to the river would be 170 cfs.

A small operation and maintenance facility would most likely be required at the town of Big Sandy.

Irrigation Benefits

The Virgelle-Havre Supplemental Water Plan provides for a supplemental water supply for the 108,140 acres.

The supplemental benefits are $45 per acre (appendix C). The annual benefits would be $4,866,000 (rounded from table 12-B).

Cost Estimates

Cost estimates for all facilities of the Virgelle-Havre Supplementary Water Plan are of reconnaissance grade at January 1976 price levels. The total project cost of the plan is estimated at $22,140,000, as shown in table 19-B. Table 20-B shows interest during construction, and table 21-B shows annual equivalent value.

TABLE 19-B

COST ESTIMATES

Virgelle Pumping Plant	$ 4,440,000
Virgelle-Havre Canal	11,000,000
Regulation Dam and Reservoir	6,700,000
TOTAL INSTALLATION COST	$22,140,000

TABLE 20-B

INTEREST DURING CONSTRUCTION

Construction Year	Installation Cost		Yrs. Int.	
1	$ 332,000	x	3.5	$ 1,162,000
2	6,088,000	x	2.5	15,220,000
3	12,177,000	x	1.5	18,265,500
4	3,543,000	x	.5	1,771,500
	$ 22,140,000			$36,419,000
				x .06125
TOTAL INTEREST DURING CONSTRUCTION				$ 2,230,664
			Rounded	$ 2,231,000

TABLE 21-B

ANNUAL EQUIVALENT VALUE

Installation Cost	$22,140,000
Interest During Construction	2,231,000
TOTAL PROJECT COST	$24,371,000
Amortization Factor	x .06141
Annual Equivalent Value	$ 1,496,623
Rounded	$ 1,497,000

Operation, Maintenance, and Replacement Costs

The OM&R costs for the Supplemental Plan are $111,000. Pumping power costs are $45,000 based on 2.5 mill power for the Pick-Sloan Missouri River Basin Power Plan. This power could be used if excess power is available. Presently, all power from P-SMRBPP is being used.

Plan Evaluation

Table 22-B shows the comparison of benefits and costs for the NED Account and RD Account, using MOP procedures.

TABLE 22-B

VIRGELLE-HAVRE SUPPLEMENTARY WATER SERVICE PLAN

NED ACCOUNT		
BENEFICIAL EFFECTS		
Irrigation		$4,866,000
ADVERSE EFFECTS		
Investment	$1,497,000	
OM&R	66,000	
Pumping	45,000	
TOTAL ADVERSE EFFECTS		-1,608,000
NET BENEFICIAL EFFECTS		$3,258,000
RD ACCOUNT		
BENEFICIAL EFFECTS		
User Benefits		
Irrigation		$4,866,000
Regional Benefits		
Employment	$ 180,000	
Induced & stemming	5,450,000	
Total Regional Benefits		5,630,000
TOTAL BENEFICIAL EFFECTS		$10,496,000
ADVERSE EFFECTS		
Investment	$1,497,000	
OM&R	66,000	
Pumping	45,000	
TOTAL ADVERSE EFFECTS		-$1,608,000
NET BENEFICIAL EFFECTS		$8,888,000

The following analyses were used in developing the SWB Account:

1. Construction employment would range from about 50 to 170 workers over the three-principal-year construction period.

2. Assuming that 40 percent of the labor is locally supplied, the total population influx would vary from about 70 to 230 persons. This would create short-term pressures on housing, and would require social and cultural adjustments by local citizens.

3. Increased annual income to the area, including $4,866,000 in direct income to farmers would provide an increased and stabilized economic base and enhance social well-being.

Repayment Analysis

The irrigators will be required to repay the investment costs and the operation, maintenance, and replacement (OM&R) costs. Investment costs for this plan are $24,371,000. The OM&R costs are $111,000 or $1.03 per acre.

Irrigators would have the option of repaying the costs under one of the following repayment plans.

Repayment Plan No. 1

This plan would require the investment to be repaid with interest. The irrigation district would borrow the money from a lending institution or issue bonds to be repaid in 50 years with interest. An interest rate of 8 percent was used to derive an annual payment of $1,992,000 or $18.42 per acre. The total annual payment per acre including OM&R would be $19.45.

Repayment Plan No. 2

Using this plan the irrigation district would borrow the investment from the Federal government. Repayment would be for 50 years without interest. The annual payment would be $487,000 or $4.50 per acre. The total annual payment per acre including OM&R would be $5.53.

Repayment Plan No. 3

The irrigation district would recommend that the Milk River Irrigation Project become part of the Pick-Sloan Missouri River Basin Power Plan. Repayment arrangements in the P-SMRBP Plan are that the irrigators repay to their ability, and excess power revenues would repay the balance of the investment cost. Present repayment criteria suggests that irrigators repay at least 25 percent of the investment. Using this procedure, the annual per acre cost would be $122,000 or $1.13 per acre. The total annual payment per acre including OM&R would be $2.16.

ALTERNATIVE NO. 3: TELEGRAPH CREEK-BEAVER CREEK

Full Service Plan

Plan of Development

The principal purpose of this plan is to provide supplemental water service to the Milk River Valley and irrigation development of 2,000 acres of new land en route by pumping from Fort Peck Reservoir. The irrigable land lies in an area known as Sun Prairie. A pumping plant located near the mouth of Telegraph Creek where it enters Fort Peck Reservoir would lift water from Fort Peck Reservoir to be conveyed by a 60-mile canal to the existing Nelson South Feeder Canal which terminates in Nelson Reservoir. After regulation, the water would be released down the river to supply supplemental water to existing irrigation developments. En route to the Milk River, a distribution system would be constructed to provide gravity irrigation service to 2,000 acres of new land.

Proposed Plan

The project works associated with this plan are discussed in downstream order as follows:

To divert water from Fort Peck Reservoir, a 240 cfs pumping plant lifting the water 180 feet to a conveyance canal would be required. The canal would extend for 60 miles. It would have an initial capacity of 240 cfs and a terminal capacity of 180 cfs when entering Nelson South Feeder Canal. Major structures on the canal would consist of one siphon, one mile long; numerous bridges for crossing; and lateral and terminal turnouts. There would also be several drainage inlets and cross drainage structures. The upper end of all major structures would be equipped with appropriate protective and escape devices, as mentioned for Route 1.

Fourteen miles of Nelson South Feeder Canal would be enlarged.

No additional facilities would be required at Nelson Dam and Reservoir. During the irrigation season the additional release to the river would be 180 cfs.

Laterals were estimated on a per acre basis. Concrete lining was assumed for all laterals with capacities of 50 cfs or less.

Due to the topography of the irrigable lands, portions of the 2,000 acres could require further pumping.

Drainages required for the project lands were estimated on a per acre basis.

Deferred additional waterways costs to the pumping plant are included in the estimate, should Fort Peck Reservoir have a change in operation, resulting in a lower normal water surface. If this should happen, further intake construction would be required for the pumping plant.

The existing operation and maintenance facilities at the community of Malta could be used, reducing the need for construction of a new facility.

Irrigation Benefits

The Telegraph Creek-Beaver Creek Full Service Plan provides for supplemental water service to 108,140 acres, and full water service to 2,000 new acres in the Milk River Valley. Benefits per acre, as determined in the farm budget analysis, amount to $45 for supplemental service and $70 for full irrigation service.

Computation of benefits is summarized in table 23-B. Note that full service benefits to new lands are discounted by a development factor of .891 to compensate for time required to adjust agricultural techniques to fully utilize the additional productive potential.

TABLE 23-B

BENEFITS FOR THE TELEGRAPH CREEK-BEAVER CREEK ROUTE

FULL SERVICE:		
2,000 acres x $70/acre x .891 =		$ 124,740
SUPPLEMENTAL SERVICE:		
108,140 acres x $45/acre =		4,866,300
TOTAL ANNUAL BENEFITS		$4,991,040
	Rounded	$4,991,000

Cost Estimates

Cost estimates for all facilities of the Telegraph Creek-Beaver Creek Full Service Plan are of reconnaissance grade at January 1976 price levels. The total project cost of the plan is estimated at $31,220,000 as summarized in table 24-B. Table 25-B shows interest during construction, and table 26-B shows the annual equivalent value.

TABLE 24-B

COST ESTIMATES

Telegraph Creek Pumping Plant	$ 4,620,000
Deferred Waterways Construction	1,340,000
Telegraph Creek-Beaver Creek Canal	18,570,000
Nelson Feeder Canal Enlargement	1,800,000
Sun Prairie Irrigation Facilities	3,200,000
Transmission Lines	1,690,000
TOTAL INSTALLATION COST	$31,220,000

TABLE 25-B

INTEREST DURING CONSTRUCTION

Construction Year	Installation Cost	Yrs. Int.	
1	$ 500,000	4.5	$ 2,250,000
2	6,000,000	3.5	21,000,000
3	9,000,000	2.5	22,500,000
4	8,000,000	1.5	12,000,000
5	7,720,000	.5	3,860,000
	$31,220,000		$61,610,000
			x .06125
TOTAL INTEREST DURING CONSTRUCTION			$ 3,773,613
		Rounded	$ 3,774,000

TABLE 26-B

ANNUAL EQUIVALENT VALUE

Installation Cost		$31,220,000
Interest During Construction		3,774,000
TOTAL PROJECT COST		$34,994,000
Amortization Factor		x .06141
Annual Equivalent Value		$ 2,148,982
	Rounded	$ 2,149,000

Operation, Maintenance, and Replacement Costs

Annual OM&R costs for the Telegraph Creek-Beaver Creek Full Service Plan are $154,800. Pumping power costs are estimated at $41,500 based on 2.5 mill power from the Pick-Sloan Missouri River Basin Power Plan. This power could be used if excess power is available. Presently, all power from P-SMRBPP is being used.

Plan Evaluation

The National Economic Development Account (NED), the Regional Development Account (RD), and the Social Well-Being Account (SWB) were developed by MOP procedures. Table 27-B shows the NED and RD Accounts.

TABLE 27-B

TELEGRAPH CREEK-BEAVER CREEK FULL SERVICE PLAN

NED ACCOUNT		
BENEFICIAL EFFECTS		
Irrigation		$4,991,000
ADVERSE EFFECTS		
Investment	$2,149,000	
OM&R	113,300	
Power	41,500	
TOTAL ADVERSE EFFECTS		- 2,303,800
NET BENEFICIAL EFFECTS		$2,687,200
RD ACCOUNT		
BENEFICIAL EFFECTS		
User Benefits		
Irrigation		$ 4,991,000
Regional Benefits		
Employment	$ 213,000	
Induced & stemming	5,590,000	
Total Regional Benefits		5,803,000
TOTAL BENEFICIAL EFFECTS		$10,794,000

ADVERSE EFFECTS		
Investment	$2,149,000	
OM&R	113,300	
Power	41,500	
TOTAL ADVERSE EFFECTS		- 2,303,800
NET BENEFICIAL EFFECTS		$8,490,200

The following analyses were used in developing the SWB Account:

1. Annual construction employment would range from about 80 to 120 workers during the four-year construction period.

2. Assuming that 40 percent of the construction labor force is locally supplied, the total population influx during the construction period would vary from about 110 to 170 people. Thus, there would be an increased short-term demand for housing, supplied principally by mobile homes. The influx would also require social and cultural adjustments by local citizens.

3. Increased annual income to the area, including $4,991,000 in direct income to farmers from irrigation, would provide an increased and stabilized economic base and enhance social well-being.

Cost Allocation

Investment costs were allocated to determine repayment of the project investment costs. The investment cost required to provide water for the supplemental acres and the new full irrigated acres would be different.

The procedure used to allocate costs was to determine the investment cost that would provide a water supply to the supplemental acres. This investment cost was subtracted from the total investment costs for the Full Service Plan. The difference after subtracting this cost is the investment cost allocated to the new full irrigated acres.

Derivation of the investment costs for the supplemental acres is shown in table 28-B.

TABLE 28-B

TELEGRAPH CREEK-BEAVER CREEK INVESTMENT COSTS

	Supplemental Acres
Construction Cost	$28,020,000
Interest During Construction	3,390,000
Investment Cost	$31,410,000
	Investment Costs
Full Service Plan	$34,994,000
Supplemental Acres	- 31,410,000
New Full Irrigated Acres	$ 3,584,000

Operation, maintenance, and replacement costs (table 29-B) were allocated using the same procedure.

TABLE 29-B

OM&R COSTS

Full Service Plan	$154,800
Supplemental Acres	- 143,500
New Full Irrigated Acres	$ 11,300

Repayment Analysis

The irrigators will be required to repay the investment costs and the operation, maintenance, and replacement (OM&R) costs.

Investment costs for this plan are $34,994,000. The OM&R costs are $154,800. OM&R costs for the full water supply are $11,300 or $5.65 per acre and for the supplementary water supply $143,500 or $1.33 per acre.

Irrigators would have the option of repaying the costs under one of the following repayment plans.

Repayment Plan No. 1

This plan would require the investment to be repaid with interest. The irrigation district would borrow the money from a lending institution or issue bonds to be repaid in 50 years with interest. An interest rate of 8 percent

was used to derive an annual payment of $2,567,000 for the supplementary water supply or $23.74 per acre and an annual payment of $293,000 for the new full water supply or $146.50 per acre. The total annual payment per acre for the supplementary water supply acres is $25.07 for the new full water supply acres is $152.15.

Repayment Plan No. 2

Using this plan the irrigation district would borrow the investment from the Federal government. Repayment would be for 50 years without interest. The annual payment would be $628,000 for the supplementary water supply acres or $5.81 per acre and an annual payment of $72,000 for the new full water supply acres or $36.00 per acre. The total annual payment per acre for the supplementary water supply acres is $7.14 and for the new full water supply acres $41.65.

Repayment Plan No. 3

The irrigation district would recommend that the Milk River Irrigation Project become part of the Pick-Sloan Missouri River Basin Power Plan. Repayment arrangements in the P-SMRBP Plan are that the irrigators repay to their ability and excess power revenues would repay the balance of the investment cost. Present criteria suggests that irrigators repay at least 25 percent of the investment. Using this procedure the annual per acre cost would be $18,000 or $9.00 per acre for the new full water supply acres and $157,000 or $1.45 per acre for the supplemental water supply acres. The total annual payment per acre including OM&R would be $2.78 for the supplementary water supply acres and $14.65 for the new full water supply acres.

Supplemental Water Service Plan

Plan of Development

This plan is identical to the Full Service Plan, excluding the development of the 2,000 irrigable acres of new land en route. Because of the small quantity of new land to be developed, the same quantities and estimates were used for this plan; only the lateral and drainage costs were deleted.

Irrigation Benefits

The Telegraph Creek-Beaver Creek Supplemental Plan provides for supplementary water service to 108,140 acres. Benefits per acre, as determined in the farm budget analysis (appendix C), amount to $45 for the supplemental service. The annual benefits would be $4,866,000 (rounded from table 23-B).

Cost Estimates

Cost estimates for all facilities of the Supplemental Service Plan are of reconnaissance grade at January 1976 price levels. The total project cost of the plan is estimated at $28,020,000 (table 30-B). Table 31-B shows interest during construction, and table 32-B shows annual equivalent value.

TABLE 30-B

COST ESTIMATES

Telegraph Creek Pumping Plant	$ 4,620,000
Deferred Waterways Construction	1,340,000
Telegraph Creek-Beaver Creek Canal	18,570,000
Nelson Feeder Canal Enlargement	1,800,000
Transmission Lines	1,690,000
TOTAL INSTALLATION COST	$28,020,000

TABLE 31-B

INTEREST DURING CONSTRUCTION

Construction Year	Installation Cost	Yrs. Int.	
1	$ 400,000	3.5	$ 1,400,000
2	7,700,000	2.5	19,250,000
3	15,400,000	1.5	23,100,000
4	4,520,000	.5	2,260,000
			$46,010,000
			x .06125
TOTAL INTEREST DURING CONSTRUCTION			$ 2,818,113
		Rounded	$ 2,818,000

TABLE 32-B

ANNUAL EQUIVALENT VALUE

Installation Cost	$28,020,000
Interest During Construction	2,818,000
TOTAL PROJECT COST	$30,838,000
Amortization Factor	x .06141
Annual Equivalent Value	$ 1,893,762
Rounded	$ 1,894,000

Operation, Maintenance, and Replacement Costs

Annual OM&R costs for the Telegraph Creek-Beaver Creek Supplemental Water Service Plan are $143,500. Pumping costs are $41,500, based on 2.5 mill power from the Pick-Sloan Missouri River Basin Power Plan. This power could be used if excess power is available. Presently, all power from P-SMRBPP is being used.

Plan Evaluation

Table 33-B summarizes the comparison of benefits and costs, determined by MOP procedures, for the NED and RD Accounts.

TABLE 33-B

TELEGRAPH CREEK-BEAVER CREEK SUPPLEMENTAL WATER SERVICE PLAN

NED ACCOUNT		
BENEFICIAL EFFECTS		
Irrigation		$4,866,000
ADVERSE EFFECTS		
Investment	$1,894,000	
OM&R	102,000	
Power	41,500	
TOTAL ADVERSE EFFECTS		- 2,037,500
NET BENEFICIAL EFFECTS		$2,828,500
RD ACCOUNT		
BENEFICIAL EFFECTS		
User Benefits		
Irrigation		$ 4,866,000
Regional Benefits		
Employment	$ 192,000	
Induced & stemming	5,450,000	
Total Regional Benefits		5,642,000
TOTAL BENEFICIAL EFFECTS		$10,508,000

ADVERSE EFFECTS		
Investments	$1,894,000	
OM&R	102,000	
Power	41,500	
TOTAL ADVERSE EFFECTS		- 2,037,500
NET BENEFICIAL EFFECTS		$ 8,470,500

The following analyses were used in developing the SWB Account:

1. Construction employment would range from about 60 to 210 workers during the three-year construction period.

2. Assuming that 40 percent of the construction labor force is locally supplied, the total population influx during the construction period would vary from about 80 to 300 people. Thus, there would be an increased short-term demand for housing, supplied principally by mobile homes. The influx would also require social and cultural adjustments by local citizens.

3. Increased annual income to the area, including $4,866,000 in direct income to farmers from irrigation, would provide an increased and stabilized economic base and enhance social well-being.

Repayment Analysis

The irrigators will be required to repay the investment costs and the operation, maintenance, and replacement (OM&R) costs. Investment costs for this plan are $30,838,000. The OM&R costs are $143,500 or $1.33 per acre.

Irrigators would have the option of repaying the costs under one of the following repayment plans.

Repayment Plan No. 1

This plan would require the investment to be repaid with interest. The irrigation district would borrow the money from a lending institution or issue bonds to be repaid in 50 years with interest. An interest rate of 8 percent was used to derive an annual payment of $2,521,000 or $23.31 per acre. The total annual payment per acre including OM&R would be $24.64.

Repayment Plan No. 2

Using this plan the irrigation district would borrow the investment from the Federal government. Repayment would be for 50 years without interest. The annual payment would be $617,000 or $5.71 per acre. The total annual payment per acre including OM&R would be $7.04.

Repayment Plan No. 3

The irrigation district would recommend that the Milk River Irrigation Project become part of the Pick-Sloan Missouri River Basin Power Plan. Repayment arrangements in the P-SMRBP Plan are that the irrigators repay to their ability and excess power revenues would repay the balance of the investment cost. Presently, the irrigators are requested to repay at least 25 percent of the investment. Using this procedure the annual per acre cost would be $154,000 or $1.42 per acre.

The total annual payment per acre including OM&R would be $2.75.

ALTERNATIVE NO. 4: DUCK CREEK-VANDALIA

Full Service Plan

Plan of Development

The principal purpose of this plan is to provide supplemental water service to the Milk River Valley and service irrigation development of 19,000 irrigable acres of new land in the Vandalia Area by diverting water from Fort Peck Reservoir. By excavating a channel from the South Fork Duck Creek Arm of Fort Peck Reservoir to the Willow Creek Drainage, water from Fort Peck Reservoir would be conveyed by 31 miles of canal through the Vandalia Area to the Milk River. En route to the river, a distribution system would be constructed to provide full service to 18,000 acres of existing irrigated lands and 19,000 acres of new lands in the Vandalia Area. By providing a full water supply to the existing 18,000 acres now being irrigated in the Vandalia Area, water now being passed upstream may be used to supplement lands above Vandalia. Further relifting of a portion of the water from the conveyance canal would be required to serve some 700 acres of the new lands. In addition to the 19,000 acres of new land identified in this plan, 8,000 irrigable acres on Glasgow Bench could also be served from a main lateral extending from the proposed main conveyance canal. Included is a separate Engineering Analysis and Estimate for Glasgow Bench (Appendix D), as this land was not included in the Full Service Plan.

Proposed Plan

The project works associated with this plan are discussed in downstream order as follows:

To divert water by gravity from Fort Peck Reservoir, a cut of approximately 100 feet through the South Fork Duck Creek Arm would be required. A conveyance canal having an initial capacity of 650 cfs and a terminal capacity of 170 cfs would extend 31 miles to the Milk River. The initial capacity of 650 cfs would include diversion requirements for the 8,000 acres of new lands on Glasgow Bench. Major structures on the canal would consist of two siphons, ¼ to ½ mile long; two drops; and lateral and farm turnouts. There would also be several drainage inlets and cross drainage structures. The upper end of all major structures would be equipped with appropriate protection and escape devices, as mentioned for Route 1.

Laterals were estimated on a per acre basis. Concrete lining was assumed for all laterals with capacities of 50 cfs or less.

Approximately 700 irrigable acres in the Vandalia Area will require further pumping of 50 feet or less from the main canal.

Project drains for the new lands were estimated on a per acre basis.

A deferred pumping plant is included in the estimate. Should Fort Peck Reservoir have a change in operation resulting in a lower normal water surface, a pumping plant would be required at the Reservoir.

The existing operation and maintenance facilities for the Vandalia Area would most likely be expanded to meet the requirements of the new lands. For this report, no additional money was included for such an expansion.

Irrigation Benefits

The Duck Creek-Vandalia Full Service Plan provides for supplemental water service to a total of 53,200 acres, and full water service to 19,000 new acres.

The 18,000 acres on the Vandalia Unit is provided a full water supply under this plan. The annual benefits would be $810,000 computed as follows:

18,000 acres x $45 per acre = $810,000

The procedure used to develop the 35,200 acres that would have a supplemental water supply upstream of the Vandalia Unit is as follows:

An operations study on the Milk River Irrigation Project of 108,140 acres shows that the future water shortage is 51,500 acre-feet. A similar operations study on the Milk River Irrigation Project with the diversion of 63,000 acre-feet for the Vandalia Unit still shows that the future water shortage is 34,600 acre-feet. A comparison of the operations studies shows that 16,900 acre-feet of water is available to provide a supplemental supply to 35,200 acres on the Milk River Irrigation Project above the Vandalia Unit. The 35,200 acres is derived by dividing:

$$\frac{16{,}900 \text{ acre-feet}}{.48 \text{ acre-feet/acre}} = 35{,}200 \text{ acres}$$

The .48 acre-feet/acre is the difference between a full supply of 3.50 acre-feet/acre and the present supply of 3.02 acre-feet/acre. The annual benefit from 35,200 acres would be as follows:

35,200 acres x $45/acre = $1,584,000

The 19,000 acres of new irrigation would have an annual benefit of $1,330,000. Irrigation benefits from new lands are adjusted with a five-year development factor. The development factor is used because all the new land will not be in production by Year one, but will be staged over a five-year period. The five-year development factor for 6 1/8 percent is .891. The adjusted annual equivalent irrigation benefits would be $1,185,000.

TABLE 34-B

BENEFITS FOR THE DUCK CREEK-VANDALIA ROUTE

FULL SERVICE:		
New Lands:	19,000 acres x $70/acre x .891 =	$1,185,000
SUPPLEMENTAL:		
Vandalia Unit:	18,000 acres x $45/acre =	810,000
Milk River Project:	35,200 acres x $45/acre =	1,584,000
TOTAL ANNUAL BENEFITS		$3,579,000

Cost Estimates

The total cost estimate for the Vandalia Unit, Full Service is $48,680,000. This includes $5,000,000 for a pumping plant on Fort Peck Reservoir that would be required if the Corps of Engineers were to change the operations of the reservoir. As now operated, the water would be diverted from Fort Peck by gravity and carried by gravity through a main supply canal to the Vandalia Unit and the new lands.

Costs for the plan were analyzed with the pumping plant being delayed for 25 years before it would be built. Table 35-B summarizes the costs for the component parts of the plan. Table 36-B shows interest during construction, and Table 37-B shows annual equivalent value.

TABLE 35-B

COST ESTIMATES

Duck Creek Pumping Plant (Deferred)	$ 5,000,000
Duck Creek-Vandalia Canal	23,000,000
Vandalia Irrigation Facilities	20,180,000
Transmission Line (Deferred)	360,000
TOTAL CONSTRUCTION COST	$48,540,000
Settlers Assistance	140,000
TOTAL INSTALLATION COST	$48,680,000

TABLE 36-B

INTEREST DURING CONSTRUCTION

Costs Without Pumping Plant

Construction Year	Installation Cost		Yrs. Int.		
1	$ 600,000	x	4.5	=	$ 2,700,000
2	10,000,000	x	3.5	=	35,000,000
3	13,000,000	x	2.5	=	32,500,000
4	12,000,000	x	1.5	=	18,000,000
5	7,720,000	x	.5	=	3,860,000
	$43,320,000				$92,060,000
					x .06125
TOTAL INTEREST DURING CONSTRUCTION					$ 5,638,675
			Rounded		$ 5,639,000

Pumping Plant

Construction Year	Installation Cost		Yrs. Int.		
1	$ 100,000	x	2.5	=	$ 250,000
2	1,900,000	x	1.5	=	2,850,000
3	3,360,000	x	.5	=	1,680,000
	$ 5,360,000				$ 4,780,000
					x .06125
TOTAL INTEREST DURING CONSTRUCTION					$ 292,775
			Rounded		$ 293,000

TABLE 37-B

ANNUAL EQUIVALENT VALUE

Costs Without Pumping Plant

Installation Cost	$43,320,000
Interest During Construction	5,639,000
TOTAL PROJECT COST	$48,959,000
Amortization Factor	x .06141
Annual Equivalent Value	$ 3,006,572
Rounded	$ 3,007,000

Pumping Plant

Installation Cost	$5,000,000
Interest During Construction	293,000
TOTAL PROJECT COST	$5,293,000

Annual Equivalent Value = Investment Costs x Present Worth Factor for 25 years x Amortization Factor

Annual Equivalent Value = $5,293,000 x .2262 x .06141

= $ 73,524
Rounded = $ 73,000

Operation, Maintenance, and Replacement Costs

The OM&R costs for the Vandalia Plan, Full Service, are $177,700. The power costs would be $17,900 based on 2.5 mill power from the Pick-Sloan Missouri River Basin Power Plan. This power could be used if excess power is available. Presently, all power produced from the P-SMRBPP is being used. A 25-year delay in construction of the pumping plant would cause the power costs to have a present value of $4,000.

Plan Evaluation

Evaluation of the plan is done using MOP procedures. The plan was analyzed under the National Economic Development Account (NED), the Regional Development Account (RD), and the Social Well-Being Account (SWB). Table 38-B shows the NED and RD accounts.

TABLE 38-B

DUCK CREEK-VANDALIA FULL SERVICE PLAN

NED ACCOUNT

BENEFICIAL EFFECTS		
Irrigation		$ 3,579,000
ADVERSE EFFECTS		
Investment	$4,080,000	
OM&R	163,800	
TOTAL ADVERSE EFFECTS		-3,243,800
NET BENEFICIAL EFFECTS		$ 335,200

	RD ACCOUNT	
BENEFICIAL EFFECTS		
User Benefits		
Irrigation		$3,579,000
Regional Benefits		
Employment	$ 361,000	
Induced & stemming	4,008,000	
Total Regional Benefits		4,369,000
TOTAL BENEFICIAL EFFECTS		$7,948,000
ADVERSE EFFECTS		
Investment	$3,080,000	
OM&R	163,800	
TOTAL ADVERSE EFFECTS		-3,243,800
NET BENEFICIAL EFFECTS		$4,704,200

The following analyses were used in developing the SWB account:

1. Construction employment would range from about 100 to 200 workers over the four-year construction period.

2. The total population influx during the construction period would vary from about 140 to 280 persons, assuming that 40 percent of the labor is locally supplied. Short-term pressures on housing would be created, and the influx would require social and cultural adjustments by local citizens.

3. Increased annual income to the area including $3,579,000 in direct income to farmers from irrigation, would provide an increased and stabilized economic base and enhance social well-being.

Cost Allocation

Investment costs were allocated to determine repayment of the project investment costs. The investment cost required to provide water for the supplemental acres and the new full irrigated acres would be different.

The procedure used to allocate costs was to determine the investment cost that would provide a water supply to the supplemental acres. This investment cost was subtracted from the total investment costs for the Full Service Plan. The difference after subtracting this cost is the investment cost allocated to the new full irrigated acres. Derivation of the investment costs for the supplemental acres is shown in table 39-B.

TABLE 39-B

DUCK CREEK-VANDALIA INVESTMENT COSTS

SUPPLEMENTAL ACRES

	First 25 Years	Second 25 Years
Construction Cost	$20,000,000	$23,360,000
Interest During Construction	2,600,000	2,803,000
Investment Cost	$22,600,000	$26,163,000

INVESTMENT COST

	First 25 Years	Second 25 Years
Full Service Plan	$48,959,000	$54,252,000
Supplemental Acres	-22,600,000	-26,163,000
New Full Irrigation Acres	$26,359,000	$28,089,000

Operation, maintenance, and replacement costs were allocated using the same procedure.

TABLE 40-B

OM&R COSTS

	First 25 Years	Second 25 Years
Full Service Plan	$159,800	$177,700
Supplemental Acres	-57,300	-65,500
New Full Irrigated Acres	$102,500	$112,200

Repayment Analysis

The irrigators will be required to repay the investment costs and the operation, maintenance, and replacement (OM&R) costs.

Investment costs for this plan are $54,252,000. The OM&R costs are $177,700. Supplemental water service is $57,300 or $1.08 per acre for the first 25 years and $65,500 or $1.23 per acre for the last 25 years. The new full water service is $102,500 or $5.39 per acre the first 25 years and $112,200 or $5.91 per acre for the last 25 years.

Repayment Plan No. 1

This plan would require the investment to be repaid with interest. The irrigation district would borrow the money from a lending institution or issue bonds to be repaid in 50 years with interest. An interest rate of 8 percent was used to derive an annual payment of $1,847,000 for the supplemental service or $34.72 per acre and $2,155,000 for the new full service or $113,42 per acre for the first 25 years. The last 25 years the supplemental service annual payment would be $2,139,000 or $40.21 per acre and the new full service annual payment would be $2,296,000 or $120.84 per acre. The total annual payment per acre including OM&R is as follows:

	First 25 Years	Second 25 Years
Supplemental Service	$ 35.80	$ 41.44
New Full Service	$118.81	$126.75

Repayment Plan No. 2

Using this plan the irrigation district would borrow the investment from the Federal government. Repayment would be for 50 years without interest. The annual payment and per acre payment for the first 25 years and the last 25 years are as follows:

	First 25 Years		Second 25 Years	
	Annual	Per Acre	Annual	Per Acre
Supplemental Service	$452,000	$ 8.50	$523,000	$ 9.83
New Full Service	$527,000	$27.74	$562,000	$29.58

The total annual per acre payment including OM&R is as follows:

	First 25 Years	Second 25 Years
Supplemental Water Supply Acres	$ 9.58	$11.06
New Full Water Supply Acres	$33.13	$35.49

Repayment Plan No. 3

The irrigation district would recommend that the Milk River Irrigation Project become part of the Pick-Sloan Missouri River Basin Power Plan. Repayment arrangements in the P-SMRBP Plan are that the irrigators repay to their ability, and excess power revenues would repay the balance of the investment cost. Present criteria suggests that irrigators repay at least 25 percent of the investment. Using this procedure the annual cost and per acre cost are as follows:

	First 25 Years		Second 25 Years	
	Annual	Per Acre	Annual	Per Acre
Supplemental Water Supply Acres	$113,000	$2.12	$131,000	$2.46
New Full Water Supply Acres	$132,000	$6.95	$140,000	$7.37

The total annual per acre payment including OM&R is as follows:

	First 25 Years	Second 25 Years
Supplemental Water Supply Acres	$3.20	$3.69
New Full Water Supply Acres	$11.34	$13.28

Supplemental Water Service Plan

Plan of Development

The single purpose of this plan is to provide supplemental water service to the Milk River Valley by diverting water from Fort Peck Reservoir. By excavating a channel from the South Fork Duck Creek Arm of Fort Peck Reservoir to the Willow Creek Drainage, water from Fort Peck Reservoir would be conveyed by 31 miles of canal through the Vandalia Area to the Milk River. En route to the river, water would be diverted to the existing Vandalia Canal to provide a full water supply to the existing 18,000 acres of irrigated lands. Water now being passed upstream may then be used to supplement irrigated lands above Vandalia.

Proposed Plan

The project works associated with this plan are discussed in downstream order as follows:

To divert water by gravity from Fort Peck Reservoir, a cut of approximately 100 feet through the South Fork Duck Creek Arm would be required. A conveyance canal having an initial capacity of 260 cfs and a terminal capacity of 90 cfs would extend 31 miles to the Milk River. Major structures on the canal would consist of two siphons, ¼ to ½ mile long; two drops; and laterals to the existing Vandalia Canal to provide full service to the existing irrigated lands. There would also be several drainage inlets and cross drainage structures. The upper end of all major structures would be equipped with appropriate protection and escape devices, as mentioned for Route 1.

Irrigation Benefits

The 18,000 acres on Vandalia Unit are provided a full water supply under this plan. Benefits per acre are $45 for the supplemental service (appendix C). The annual benefits would be $810,000 (table 34-B).

Annual benefits were computed for the additional 35,200 acres as follows:

An operations study on the Milk River Irrigation Project of 108,140 acres shows that the future water shortage is 51,500 acre-feet. A similar operations study on the Milk River Irrigation Project with the diversion of 63,000 acre-feet from the Fort Peck Reservoir to serve the 18,000 acres of the Vandalia Unit shows that the future water shortage is 34,600 acre-feet. A comparison of the operations studies shows that 16,900 acre-feet of water is available to serve an additional 35,200 acres of the Milk River Irrigation Project, a supplemental water supply above the Vandalia Unit. The 35,200 acres is derived by dividing $\frac{16,900 \text{ acre-feet}}{.48 \text{ acre-feet/acre}}$

The .48 acre-feet/acre is the difference between a full supply of 3.50 acre-feet/acre and the future supply of 3.02 acre-feet/acre with 51,500 acre-feet of shortage. The annual benefits for 35,200 acres would be $1,584,000 computed as follows:

35,200 acres x $45 per acre = $1,584,000

The total annual direct irrigation benefits for Vandalia Plan are $2,394,000.

Cost Estimates

The total cost estimate for the Vandalia Plan is $23,360,000. This includes $3,360,000 for a pump on Fort Peck Reservoir that would be required if the Corps of Engineers were to change the operations of the reservoir. As now operated, the water would be diverted from Fort Peck by gravity and carried by gravity through a main supply canal to the Vandalia Unit.

Cost estimates for all facilities of the Supplementary Water Service Plan are of reconnaissance grade at January 1976 price levels. The total project cost of the plan is estimated at $23,360,000, as summarized in table 41-B.

TABLE 41-B

COST ESTIMATES

Duck Creek Pumping Plan (Deferred)	$ 3,000,000
Duck Creek-Vandalia Canal	20,000,000
Transmission Line	360,000
TOTAL INSTALLATION COST	$23,360,000

Costs for the plan were analyzed with the pump being delayed for 25 years before it would be built.

An interest rate of 6 1/8 percent was used for the economic analysis. Interest during construction and annual equivalent values are shown in tables 42-B and 43-B.

TABLE 42-B

INTEREST DURING CONSTRUCTION

Costs Without Pumping Plant

Construction Year	Installation Cost		Yrs. Int.		
1	$ 300,000	x	3.5	=	$ 1,050,000
2	5,500,000	x	2.5	=	13,750,000
3	11,000,000	x	1.5	=	16,500,000
4	3,200,000	x	.5	=	1,600,000
	$20,000,000				$32,900,000
					x .06125
TOTAL INTEREST DURING CONSTRUCTION					$ 2,015,125
			Rounded		$ 2,015,000

Pumping Plant

Construction Year	Installation Cost		Yrs. Int.		
1	$ 100,000	x	2.5	=	$ 250,000
2	1,900,000	x	1.5	=	2,850,000
3	1,360,000	x	.5	=	680,000
	$ 3,360,000				$ 3,780,000
					x .06125
TOTAL INTEREST DURING CONSTRUCTION					$ 231,525
			Rounded		$ 232,000

TABLE 43-B

ANNUAL EQUIVALENT VALUE

Costs Without Pumping Plant

Annual Equivalent Value = $22,015,000 x .06141 = $1,351,900

Pumping Plant

Annual Equivalent Value = Investment Costs x Present Worth Factor for 25 years x Amortization Factor

= $3,592,000 x .2262 x .06141
= $49,846

Rounded = $50,000

Operation, Maintenance, and Replacement Costs

The OM&R costs for the Vandalia Supplementary Water Service Plan are $65,500. The power costs would be $8,200 based on 2.5 mill power from the Pick-Sloan Missouri River Basin Power Plan. This power could be used if excess power is available. Presently, all power produced from the P-SMRBPP is being used. A 25-year delay in construction of the pumping plant would cause the power costs to have a present value of $1,900.

Plan Evaluation

The comparison of benefits and costs is developed using MOP analysis. Table 44-B shows the NED and RD Accounts.

TABLE 44-B

DUCK CREEK-VANDALIA SUPPLEMENTAL WATER SERVICE PLAN

NED ACCOUNT

BENEFICIAL EFFECTS		
Irrigation		$2,394,000
ADVERSE EFFECTS		
Investment	$1,402,000	
OM&R	59,200	
TOTAL ADVERSE EFFECTS		- 1,461,200
NET BENEFICIAL EFFECTS		$ 932,800

	RD ACCOUNT	
BENEFICIAL EFFECTS		
User Benefits		
Irrigation		$2,394,000
Regional Benefits		
Employment	$ 112,000	
Induced & stemming	2,681,000	
Total Regional Benefits		2,793,000
TOTAL BENEFICIAL EFFECTS		$5,187,000
ADVERSE EFFECTS		
Investment	$1,402,000	
OM&R	57,300	
Power	1,900	
TOTAL ADVERSE EFFECTS		- 1,461,200
NET BENEFICIAL EFFECTS		$3,725,800

The following analyses were used in developing the SWB Account:

1. Construction employment would range from 50 to 170 men over the three-year period.

2. Assuming that 40 percent of the construction labor force is locally supplied, the total population influx during the construction period would vary from about 70 to 250 people. Thus, there would be an increased short-term demand for housing, supplied principally by mobile homes. The influx would also require social and cultural adjustments by local citizens.

3. Increased annual income to the area, including $2,394,000 in direct income to farmers from irrigation, would provide an increased and stabilized economic base and enhance social well-being.

Repayment Analysis

The irrigators will be required to repay the investment costs and the operation, maintenance, and replacement (OM&R) costs. Investment costs for this plan are $25,607,000. The total OM&R costs are $65,500. OM&R costs for the first 25 years are $57,300 or $1.08 per acre and $65,500 or $1.23 per acre for the rest of the life of the project.

Irrigators would have the option of repaying the costs under one of the following repayment plans.

Repayment Plan No. 1

This plan would require the investment to be repaid with interest. The irrigation district would borrow the money from a lending institution or issue bonds to be repaid in 50 years with interest. An interest rate of 8 percent was used to derive an annual payment of $1,800,000 or $33.83 per acre for the first 25 years and an annual payment of $2,093,000 or $39.34 per acre for the remaining 25 years. The total annual payment per acre including OM&R would be $34.91 for the first 25 years and $40.57 for the second 25 years.

Repayment Plan No. 2

Using this plan the irrigation district would borrow the investment from the Federal government. Repayment would be for 50 years without interest. The annual payment would be $440,000 or $8.27 per acre the first 25 years and an annual payment of $512,000 or $9.62 per acre for the remaining 25 years. The total annual payment per acre including OM&R would be $9.35 for the first 25 years and $10.85 for the second 25 years.

Repayment Plan No. 3

The irrigation district would recommend that the Milk River Irrigation Project become part of the Pick-Sloan Missouri River Basin Power Plan. Repayment arrangements in the P-SMRBP Plan are that the irrigators repay to their ability, and excess power revenues would repay the balance of the investment cost without interest. Present criteria suggests that irrigators repay at least 25 percent of the investment. Using this procedure the annual payment would be $110,000 or $2.07 per acre for the first 25 years and $128,000 or $2.41 per acre for the second 25 years. The total annual payment per acre including OM&R would be $3.15 for the first 25 years and $3.64 for the second 25 years.

APPENDIX C

FARM BUDGET ANALYSIS
FOR
SUPPLEMENTAL WATER SUPPLY
ECONOMIC AND REPAYMENT ANALYSES
REPORT
MILK RIVER BASIN

MONTANA

Prepared by Division of Planning
Bureau of Reclamation
U.S. Department of Interior

Upper Missouri Region
P. O. Box 2553, Billings, Montana 59103

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FARM BUDGET ANALYSIS

A set of farm budgets were developed to analyze the supplemental water supply for Milk River study. Water would be diverted into the Milk River from other drainage basins. Two sources of water are the Marias River and the Missouri River basins.

Farm budgets were developed that would represent the "without project" situation or the current conditions and the "with project" situation or future conditions.

The supplemental supply brings water into the Milk River and allows the present irrigators to increase their diversion from the present supply to a full supply. Along with the supplemental supply would be the irrigation of new lands from the diversion canals. These new lands would be provided a full water supply.

The supplemental supply lands are presently irrigated. A farm budget was developed to reflect the land use and crop yields for this "without project" situation.

The new lands are presently dry-farmed. A farm budget was developed to reflect the land use and crop yields for this "without" situation. The "with project" situation is a farm budget that reflects the future land use and crop yields with a full water supply.

The livestock enterprise used in all budgets was beef cow-calf.

Farm Budget Criteria

Land Use

Land use for both the "without" and "with project" situation is based on 1971-75 crop records of the Bureau of Reclamation for the Milk River area. The land use percentages for irrigation are presented in Table 1. Land use for the dryland acres in the "without" situation was taken from the 1972-73 Montana Agricultural Statistics and the 1969 Census of Agriculture for the State of Montana. Dryland use is presented in Table 1-C.

Farm sizes for the three farm budgets (table 2-C) were based on the 1969 Census of Agriculture for Montana. The farm sizes reflect the averages for the four counties of Blaine, Hill, Phillips, and Valley. The farms in the area are large at present and it is anticipated that under project conditions they would remain that way. If future conditions follow present trends, newly irrigated lands will be used primarily to supplement the existing livestock feed base. Irrigation is expected to be integrated with dry farming as is currently found along the Milk River.

TABLE 1-C

LAND USE

Crops	Without Project Budget % Distribution	Dryland Without Project Budget % Distribution	Full Irrigation With Project % Distribution
Irrigated	100		100
Barley	6		6
Wheat	4		4
Alfalfa Hay	34		34
Other Hay	25		25
Pasture	21		21
Corn Silage	5		5
Farmstead	5		5
Dryland	100	100	100
Barley	10	5	10
Wheat	27	11	27
Native Hay	4	4	4
Fallow	40	17	40
Dryland Pasture	15	61	15
Farmstead	4	2	4

TABLE 2-C

FARM SIZE

Land Use	Irrigated Without Project (Acres/Farm)	Dryland Without Project (Acres/Farm)	Irrigated With Project (Acres/Farm)
Irrigated Cropland	230		230
Dryland Cropland	1,115	1,265	1,115
Rangeland	2,265	1,975	2,265
TOTAL	3,610	3,240	3,610

Crop Yields

Crop yields (table 3-C) for the "without project" situation on irrigated acres that have a partial water supply were based on the 1971-75 crop records of the Bureau of Reclamation on all existing Milk River projects. Dryland crop yields were taken from the 1972-73 Montana Agricultural Statistics for the counties of Blaine, Hill, Phillips, and Valley. Crop yields for irrigation with a full water supply under the "with project" condition were taken from various enterprise cost reports prepared by the Agricultural Extension Service of Montana for the four counties. These crop yields would reflect yields that would be achieved by 1985. The current average dryland yields were used for the yield in 1985. It was assumed that the average dryland yields would change very little between now and 1985.

TABLE 3-C

CROP YIELDS

Crops	Without Project	With Project
Irrigated		
Barley	41 bushels	90 bushels
Wheat (winter)	30 bushels	60 bushels
Wheat (spring)	-	50 bushels
Alfalfa Hay	2.9 tons	5.5 tons
Grass Hay	-	4.5 tons
Native Hay	1.4 tons	2.0 tons
Pasture	5.6 AUMS[a]	10.0 AUMS
Corn Silage	12.1 tons	18.0 tons
Dryland		
Barley	28 bushels	28 bushels
Wheat	26 bushels	26 bushels
Alfalfa	1.1 ton	1.1 ton
Other Hay	.95 ton	.95 ton
Pasture	1.0 AUM	1.0 AUM
Rangeland	.4 AUM	.4 AUM

[a]Animal unit months

Machinery and Buildings Costs

Costs used for machinery and equipment (table 4-C) were based on machinery prices in Montana in April 1976 and normalized using the indexes provided by the Water Resources Council. Building and improvement costs are shown in table 4-C.

TABLE 4-C

MACHINERY AND BUILDINGS COSTS

Item	Cost	Life (years)	Repair Rate
Machinery Costs			
Plow, 2 way	$ 2,912	12	.07
Tandem Disc	2,202	11	.03
Harrow Spiketooth	340	20	.01
Seed Bedder	2,387	12	.03
Chisel Plow	1.580	15	.02
Harrow Springtooth	660	20	.01
Grain Drill	2,139	14	.015
Corn and Bean Planter	2,527	10	.02
Corn Cultivator	1,355	12	.035
Swather	8,510	10	.03
Baler PTO	4,033	10	.03
Bale Wagon PTO	7,252	8	.03
Sprayer	2,401	10	.05
Ditcher	800	12	.02
Manure Spreader and Loader	6,335	15	.015
Irrigation Dams and Siphons	900	5	.05
Tractor, 50 hp	7,030	10	.035
Tractor, 80 hp	13,320	10	.035
Tractor, 120 hp	24,000	10	.035
Truck, 2 ton	11,000	10	.035
Buildings and Improvements			
Dwelling and Garage	$30,000	50	.02
Implement Shed and Shop	7,500	50	.02
Granary (1,650 bu)	1,380	30	.02
Cattle Shed	2,800	20	.02
Corrals	900	20	.02
Feed Bunks	350	10	.03
Water Troughs	250	20	.02
Pit Silo (trench)	560	50	.02
Fences (perimeter only)	$7.60/acre	20	.075

Prices Received

Prices received (table 5-C) for farm products are those derived for the State of Montana by the Water Resources Council, November, 1975. These reflect normalized price using a least squares linear regression analysis for an 11-year (1965-75) data base.

TABLE 5-C

PRICES RECEIVED

Product	Unit	Price
Alfalfa Hay (baled)	ton	$44.59
Barley	bu	1.90
Wheat	bu	3.24
Other Hay (baled)	ton	44.59
Beef Cows (utility)	cwt[a]	38.01
Replacement Heifers (900#)	cwt	39.00
Heifer Calves (425#)	cwt	42.50
Steer Calves (450#)	cwt	46.50

[a]hundredweight

Prices Paid

Prices paid (table 6-C) represent the average prices of production items found in Montana. These costs were adjusted to reflect a normalized price using the indexes for production items developed by the Water Resources Council.

TABLE 6-C

PRICES PAID

Seed Costs	
Alfalfa	$1.073/lb
Barley	8.90/cwt
Beans	35.00/cwt
Corn Grain	50.50/cwt
Corn Silage	50.50/cwt
Rotation Pasture	37.50/cwt
Sugar Beets	4.85/lb
Wheat	10.30/cwt

Fertilizer Costs	
Nitrogen	27¢/available lb
Phosphorus	14¢/available lb
Potassium	7¢/available lb

Baling Twine	
Hay	$3.00/ton
Straw	4.00/ton

Custom Farm Rates		
Spraying[a]	Alfalfa	$2.00/acre
"	Beans	2.50/acre
"	Corn	3.00/acre
"	Pasture	2.00/acre
"	Small Grains	2.00/acre
"	Sugar Beets	2.50/acre
Combining	Small Grains	8.60/acre
"	Corn	13.30/acre
"	Beans	10.00/acre
Chop and Haul	Corn Silage	2.75/ton

Miscellaneous Costs	
Gasoline	55¢/gallon
Motor Oil	80¢/quart
Oil Filter	$4.00 each
Diesel Fuel	50¢/gallon

Livestock Expenses	
Beef Cow-Calf Miscellaneous Expenses	$10.55 per Cow-Calf Unit
Shipping	60¢/cwt

Feed	
Hay	$44.59/ton
Barley	1.90/bu
Rolling Barley	.28/bu
Straw	40/ton

[a]Does not include materials

Taxes

The tax structure (table 7-C) used in the budgets represents the average found in the area. Taxes on agricultural land usually do not vary enough from county to county to affect significantly the result of the farm budget. However, for a feasibility study, the tax structure of the counties involved should be used for determination of irrigation benefits and repayment ability.

TABLE 7-C

TAX STRUCTURE

Assessed value of land	$2.60 per irrigable acre 1.50 per dryland acre
Mill levy on all property	56.763 mills
Assessed value of improvements	25% of actual value
Assessed value of machinery	15% of actual value

Land Values

Land values relfect the agricultural value of the land, not necessarily the market value. Land was valued at $200 per irrigated acre and $150 per dryland acre.

Miscellaneous Expenses

The annual values used for the farm share of miscellaneous items such as utilities and insurance are shown in table 8-C.

TABLE 8-C

MISCELLANEOUS EXPENSES

Telephone	$160
Electricity	60
Domestic Water	172
Auto and Truck License and Insurance	717
Farm Liability Insurance	29
Irrigation O&M	890

Farm Labor

The farm family is assumed to consist of a man, his wife, and two teenage children. Any labor over a maximum of 260 hours in the summer months and 220 hours in the winter months is hired at a rate of $2.75 per hour.

IRRIGATION BENEFITS

The benefits for supplemental and new full irrigation service are presented in the following tables.

Supplemental Irrigation Benefits

Table 9-C shows the supplemental benefits. The farm budget for the "without project" represents the present average conditions on the Milk River Irrigation Project as to size and land use. A shortage of .48 acre-feet of water is reflected in the crop yields by using an average of the present-day yields.

The farm budget for the "with project" uses the same size farm, but has increased yields based on a full water supply of 3.50 acre-feet and based on the yields used by the Extension Service in developing enterprise budgets by counties for the Milk River Basin.

Supplemental irrigation benefits are $45 per acre.

New Full Irrigation Benefits

Table 10-C presents the new full irrigation benefits. The "without project" farm budget is a typical dryland operation in the Milk River Basin.

The "with project" farm budget is based on converting present dryland to new irrigation development. The land use reflects the current irrigated land use in the area except for native hay. Presently, native hay is raised by irrigation. The new irrigation farm budget excludes native hay. It is more profitable to raise alfalfa.

New full irrigation benefits are $70 per acre.

TABLE 9-C

CALCULATION OF
SUPPLEMENTAL IRRIGATION BENEFITS

	Without Project	With Project	Increase
Crop Sales	$34,144	$56,222	$22,078
Livestock Sales	29,441	25,516	- 3,925
Farm Perquisites	1,887	1,887	0
Gross Income	$65,472	$83,625	$18,153
Operating Expense	$36,622	$39,653	$ 3,031
Miscellaneous Expense	732	793	61
Interest on Investment	29,131	34,381	5,250
Total Farm Expense	$66,485	$74,827	$ 8,342
Net Farm Income	$ 1,013	$ 8,798	$ 9,811
Total Acres	1,345	1,345	
Irrigated Acres	218	218	
Benefits Per Irrigated Acre			$45

TABLE 10-C

CALCULATION OF
NEW FULL IRRIGATION BENEFITS

	Without Project	With Project	Increase
Crop Sales	$37,422	$60,165	$22,743
Livestock Sales	17,861	25,516	7,655
Farm Perquisites	1,887	1,887	0
Gross Income	$57,170	$87,568	$30,398
Operating Expense	$33,912	$40,448	$ 6,536
Miscellaneous Expense	678	809	131
Interest on Investment	24,864	34,110	9,246
Total Farm Expense	$59,454	$75,367	$15,913
Net Farm Income	-$2,284	$12,201	$14,485
Total Acres	1,284	1,284	
Irrigated Acres	208	208	
Benefits Per Irrigated Acre			$69.64
Rounded			$70.00

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GLOSSARY

acre-foot (af) - the amount of water required to cover one acre to a depth of one foot (43,560 cubic feet).

aquifer - zone below the surface of the earth capable of producing water as from a well.

bentonite - clay formed by decomposition of volcanic ash which has great ability to absorb or adsorb water; used as liner for ditches.

bifurcation - forked or branched structure, Y-shaped.

capillary action - the rising or lowering of the surface of a liquid where it is in contact with a solid,due to molecular attraction.

cfs - cubic feet per second; a measure of water flow.

coal gasification - process of making gas from coal.

DNRC - Montana Department of Natural Resources and Conservation.

fluorspar - fluorite, a mineral that is the principal source of flourine.

full service supply - in this report the term designates water supply to acres newly irrigated which would require up to 3.5 acre-feet per acre per season.

lignite - a soft, brownish-black variety of coal.

microfauna - microscopic animal life forms.

NED - National Economic Development; increase of the nation's output of goods and services and improvement of economic efficiency.

niobium - also called columbium; a metallic element used in the manufacture of steel alloys, especially stainless steels.

rare earth - any of a group of oxides of metals obtained from widely distributed but relatively scarce minerals whose elements have atomic numbers 57 to 71; used in the manufacture of alloys, glass, etc.

RD - Regional Development; increase in regional income and employment and distribution of population; improvement of the regional economic base, educational, cultural, and recreational opportunities; enhancement of environmental conditions of the region.

supplemental service supply - in this report the term designates water supply acreage previously and presently irrigated which needs additional water.

tame hay - hay that is seeded.

USDI - United States Department of the Interior.

wild hay - hay that is not seeded.

vermiculite - a clay mineral; hydrous silicate of aluminium, iron and magnesium; chiefly used for heat insulation, sculptures.

Montana
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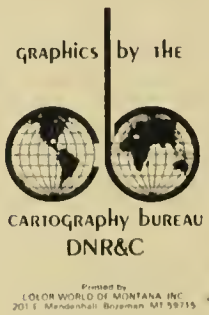
and Conservation

Helena, Montana



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